

1984

# Selected Physiological, Psychological, and Anthropometric Characteristics of the Kuwaiti World Cup Soccer Team (Athletes, Vo2 Max, Per Cent Fat).

Jasem Mohammad Ramadan

*Louisiana State University and Agricultural & Mechanical College*

Follow this and additional works at: [https://digitalcommons.lsu.edu/gradschool\\_disstheses](https://digitalcommons.lsu.edu/gradschool_disstheses)

---

## Recommended Citation

Ramadan, Jasem Mohammad, "Selected Physiological, Psychological, and Anthropometric Characteristics of the Kuwaiti World Cup Soccer Team (Athletes, Vo2 Max, Per Cent Fat)." (1984). *LSU Historical Dissertations and Theses*. 3991.  
[https://digitalcommons.lsu.edu/gradschool\\_disstheses/3991](https://digitalcommons.lsu.edu/gradschool_disstheses/3991)

This Dissertation is brought to you for free and open access by the Graduate School at LSU Digital Commons. It has been accepted for inclusion in LSU Historical Dissertations and Theses by an authorized administrator of LSU Digital Commons. For more information, please contact [gradetd@lsu.edu](mailto:gradetd@lsu.edu).

## INFORMATION TO USERS

This reproduction was made from a copy of a document sent to us for microfilming. While the most advanced technology has been used to photograph and reproduce this document, the quality of the reproduction is heavily dependent upon the quality of the material submitted.

The following explanation of techniques is provided to help clarify markings or notations which may appear on this reproduction.

1. The sign or "target" for pages apparently lacking from the document photographed is "Missing Page(s)". If it was possible to obtain the missing page(s) or section, they are spliced into the film along with adjacent pages. This may have necessitated cutting through an image and duplicating adjacent pages to assure complete continuity.
2. When an image on the film is obliterated with a round black mark, it is an indication of either blurred copy because of movement during exposure, duplicate copy, or copyrighted materials that should not have been filmed. For blurred pages, a good image of the page can be found in the adjacent frame. If copyrighted materials were deleted, a target note will appear listing the pages in the adjacent frame.
3. When a map, drawing or chart, etc., is part of the material being photographed, a definite method of "sectioning" the material has been followed. It is customary to begin filming at the upper left hand corner of a large sheet and to continue from left to right in equal sections with small overlaps. If necessary, sectioning is continued again—beginning below the first row and continuing on until complete.
4. For illustrations that cannot be satisfactorily reproduced by xerographic means, photographic prints can be purchased at additional cost and inserted into your xerographic copy. These prints are available upon request from the Dissertations Customer Services Department.
5. Some pages in any document may have indistinct print. In all cases the best available copy has been filmed.

**University  
Microfilms  
International**

300 N. Zeeb Road  
Ann Arbor, MI 48106



8511762

**Ramadan, Jasem Mohammad**

SELECTED PHYSIOLOGICAL, PSYCHOLOGICAL, AND ANTHROPOMETRIC  
CHARACTERISTICS OF THE KUWAITI WORLD CUP SOCCER TEAM

*The Louisiana State University and Agricultural and Mechanical Col.*

Ph.D. 1984

University  
Microfilms  
International 300 N. Zeeb Road, Ann Arbor, MI 48106



PLEASE NOTE:

In all cases this material has been filmed in the best possible way from the available copy.  
Problems encountered with this document have been identified here with a check mark ✓.

1. Glossy photographs or pages \_\_\_\_\_
2. Colored illustrations, paper or print \_\_\_\_\_
3. Photographs with dark background ✓
4. Illustrations are poor copy \_\_\_\_\_
5. Pages with black marks, not original copy \_\_\_\_\_
6. Print shows through as there is text on both sides of page \_\_\_\_\_
7. Indistinct, broken or small print on several pages ✓
8. Print exceeds margin requirements \_\_\_\_\_
9. Tightly bound copy with print lost in spine \_\_\_\_\_
10. Computer printout pages with indistinct print \_\_\_\_\_
11. Page(s) \_\_\_\_\_ lacking when material received, and not available from school or author.
12. Page(s) \_\_\_\_\_ seem to be missing in numbering only as text follows.
13. Two pages numbered \_\_\_\_\_. Text follows.
14. Curling and wrinkled pages \_\_\_\_\_
15. Other \_\_\_\_\_

University  
Microfilms  
International



SELECTED PHYSIOLOGICAL, PSYCHOLOGICAL, AND ANTHROPOMETRIC  
CHARACTERISTICS OF THE KUWAITI WORLD CUP SOCCER TEAM

A Dissertation

Submitted to the Graduate Faculty of the  
Louisiana State University and  
Agricultural and Mechanical College  
in partial fulfillment of the  
requirements for the degree of  
Doctor of Philosophy

in

The School of Health, Physical  
Education, Recreation and Dance

by

Jasem M. Ramadan

B. S., High Institute of Sports Education, Cairo, Egypt, 1973

M. S., Indiana University, Bloomington, Indiana, 1980

August 1984



## ACKNOWLEDGEMENTS

I am grateful to many persons who helped with this study in many ways. In particular, a very special thanks goes to the major professor and chairperson of my committee, Dr. Ronald Byrd, for his invaluable patience, leadership, and continual suggestions and guidance.

I wish to thank the other members of the dissertation committee: Professors Patrick Crawford, Evelyn Hall, Michael Mangum, and Scott Powers for their time and effort put into this investigation.

Many thanks are extended to the Kuwait University Medical School for providing the financial support; to the Kuwait Football Association for their assistance and cooperation and; to my friends, Dr. Mesaed Al-Haroun, Yousif Al-Shamlan, Hussain Ashour, and Srekanda Kumar, who provided help and support during the course of this study.

Special thanks goes to Barbara Weathers for her time, effort and support in typing my dissertation. Acknowledgements would be incomplete without mention of the athletes, whose participation and devotion made this study possible.

Also, I wish to extend my thanks to my parents, brothers, and sisters for their unlimited support and love and to my wife and son for their devotion and compassion.

Most importantly, my praise and gratitude goes to Allah the most gracious, the most merciful, who gave us all the potential to be creative and the abilities to perform.

This study is dedicated:

To my Mother...

and my Father...

whom I respect and

who have all of my Love.

## TABLE OF CONTENTS

	Page
ACKNOWLEDGEMENTS.....	ii
DEDICATION.....	iii
LIST OF TABLES.....	vi
LIST OF FIGURES.....	vii
ABSTRACT.....	ix
CHAPTER 1 - INTRODUCTION AND REVIEW OF LITERATURE.....	1
Maximal Oxygen Consumption ( $\dot{V}O_2$ max).....	3
Training and $\dot{V}O_2$ max.....	4
$\dot{V}O_2$ max in Athletes.....	6
Selected Factors Affecting $\dot{V}O_2$ max.....	7
Anaerobic Power.....	10
Training and Anaerobic Power.....	11
Power and Source of Energy.....	13
Measurement of Anaerobic Power.....	15
Anaerobic Power and Sport Performance.....	16
Body Composition and Somatotype.....	18
Body Composition.....	19
Somatotype.....	22
Psychological Characteristics and Performance.....	25
Training Effect.....	25
Psychological Characteristics of Athletes.....	27
Anxiety - State and Trait.....	33
Profile of Mood States.....	35
Statement of the Problem.....	37
Delimitations.....	37
Basic Assumptions.....	37
Significance.....	38

## TABLE OF CONTENTS - CONTINUED

	Page
CHAPTER 2 - MATERIALS AND METHODS.....	40
Subjects.....	40
Maximal Oxygen Consumption.....	40
Anaerobic Power.....	42
Somatotype.....	42
The First Component Rating (Endomorphy).....	42
The Second Component Rating (Mesomorphy).....	43
Third Component Rating (Ectomorphy).....	43
Body Composition.....	44
Psychological Testing.....	44
Statistical Analysis.....	45
CHAPTER 3 - RESULTS AND DISCUSSION.....	46
$\dot{V}O_2$ max.....	46
Anaerobic Power.....	52
Body Composition.....	61
Somatotype.....	69
Profile of Mood States and State-trait Anxiety Inventory..	78
Summary and Conclusions.....	92
BIBLIOGRAPHY.....	95
APPENDIX A.....	118
APPENDIX B.....	123
VITA.....	125

## LIST OF TABLES

Table	Page
1. Comparison of Relative $\dot{V}O_2$ max of Professional, Amateur, and Junior Amateur Soccer Players by Position.....	51
2. Anaerobic Power Comparison Among Various Sports and Events (Means $\pm$ Standard Deviations).....	53
3. Anaerobic Power of the Kuwaiti World Cup Soccer Team - Differences Between the Starters and the Substitutes.....	60
4. Per Cent Fat of Athletes of Various Sports.....	63
5. Body Composition Comparison Between Soccer, Lacrosse, and Football Players in Various Positions.....	66
6. Per Cent Fat Differences Among Positional Groupings of Soccer Players.....	68
7. Means and Standard Deviations of Body Composition of Soccer Players.....	70
8. Body Composition of World Class Soccer Players - Comparison Among the Starters and the Substitutes.....	71
9. Somatotypes of Soccer Athletes - Starters, Substitutes, and Positional Group Differences.....	77
10. Profile of Mood States and State - Trait Anxiety of Soccer Players - Differences Between the Starters and the Substitutes.....	80
11. The Results of the Kuwaiti Group in the 1982 World Cup Championship.....	84

## LIST OF FIGURES

Figure	Page
1. Mean Relative Maximal Oxygen Consumption of Elite Athletes in Various Sports.....	47
2. Means and Standard Deviations for $\dot{V}O_2$ max of Elite Soccer Players.....	49
3. Comparison of Anaerobic Power of Soccer Athletes in Different Levels.....	55
4. Comparison of Anaerobic Power of Soccer Players According to Position.....	57
5. Mean Per Cent Fat of Athletes in Various Sports.....	62
6. Means of Somatotype for Various Sports.....	73
7. Somatochart of the Kuwaiti World Cup Soccer Team.....	75
8. Comparison of the Somatotypes of the Starters and the Substitutes of the Kuwaiti World Cup Soccer Team.....	76
9. Somatotypes of the Kuwaiti World Cup Soccer Players by Position Played.....	79
10. Profile of Mood State in Various Sports.....	81
11. State-Trait Anxiety Comparison of Various Sports.....	87
12. Profile of Mood States and State-Trait Anxiety Differences Between the Starters and the Substitutes of the Kuwaiti World Cup Soccer Team.....	88
13. State-Trait Anxiety and Profile of Mood States Comparison of the Kuwaiti Soccer Team by Position.....	89
14. Comparison of Profile of Mood States During and Post the World Soccer Games of the Kuwaiti Team.....	91

# LIST OF FIGURES - CONTINUED

Figure	Page
A1. Ergo-Oxyscreen Diagram.....	119
A2. Tubing Scematic Ergo-Oxyscreen.....	120
A3. Front Panel $\mu$ -Dataspir.....	121
A4. Reverse Panel $\mu$ -Dataspir.....	122
B1. POMS Translated Inventory.....	124

## ABSTRACT

The purpose of the investigation was to examine the maximal oxygen consumption ( $\dot{V}O_2$  max), maximal anaerobic power (AP max), body composition (BC), somatotype (ST), the Profile of Mood States (POMS) and the State-Trait Anxiety (STAI) characteristics of the Kuwaiti World Cup Soccer Team.

$\dot{V}O_2$  max was determined using a progressive cycle ergometer protocol with data obtained by standard semi-open circuit spirometry. AP max was calculated by using the highest value of three vertical jumps applied to the Lewis formula:  $(\sqrt{4.9 \times \text{weight} \times \sqrt{D}})$ . BC was estimated by skinfolds and ST was by the Heath-Carter method. Translated versions of POMS and STAI were used.

The Kuwaiti team exhibited moderately high aerobic ( $51.9 \text{ ml/kg}\cdot\text{min}^{-1}$ ) and anaerobic ( $119.6 \text{ kg}\cdot\text{m/sec}$ ) power, both values being significantly higher than college norms, but in the mid-ranges for world-class athletes in general. Relative body fatness (8.9%) and a balanced mesomorphic somatotype (2.1-4.5-2.1) were comparable to those of athletes in other high-level team sports. The World Cup soccer players revealed a significantly higher value in the anger factor when evaluated by POMS, contrasted to other findings on both elite athletes and college norms. This factor was determined to be normal on follow-up



testing 18 months after the World Cup Games. Finally, they also showed higher state and trait anxiety than the college norms and when compared to other athletes.

Analysis by playing position revealed the goalkeepers to have higher AP max, per cent fat, mesomorphy, and both state and trait anxiety levels, along with lower  $\dot{V}O_2$  max, compared to players of other positions. Midfielders had the highest  $\dot{V}O_2$  max and were the leanest. Offensives exhibited the lowest tension, depression, anger, confusion, and trait anxiety levels. The defensives primary differentiating characteristics was a high AP max, comparable to that of the goalkeepers. The starters were significantly older, less fat, and were higher in both state and trait anxiety than the substitutes.

The structural and functional measures taken for this study appeared to indicate that the Kuwaiti team had appropriate potential for World Cup competition. Excessively high state and trait anxiety, and anger indicates that more psychological preparation was needed.

## CHAPTER 1

### INTRODUCTION

The importance of sports to society was emphasized by Pierce, Stillner, & Popkin (1982) who stated that:

Sports can help understand how a society defines itself and regulates violence. Games may be an essential 'human-specific' need which provide entertainment, retain survival skills, ameliorate existential anxiety and promote religious and/or secular socialization (p. 11).

They further elaborated on the willingness and the insistence of humans to deploy enormous resources of material and time to maintain competitions among themselves, as well as with other species.

Coaches, athletes and exercise scientists have special interests in examining or describing those characteristics which contribute to successful sport performance. Numerous investigators have studied athletes in a variety of sports. The effects of heredity and environment have been examined, as have individual differences in function, physique, and psychological parameters.

The greatest amount of data regarding physiological attributes of champion athletes appears to be on endurance runners, whereas only a small amount of literature is available

dealing with soccer (association football). This might stem from the strong focus of exercise physiologists on cardiovascular and metabolic function and the relatively minor role that soccer has played in the United States.

There have been numerous attempts to investigate the factors that are important for soccer performance. However, most of the research has been focused on the fundamental skills, techniques, tactics, and accuracy of kicking. Therefore, there appears to be a need to draw attention to the physical, physiological, and psychological determinants of successful soccer performance.

The popularity of the game of soccer is exemplified by the number of participants and by the attractiveness of the sport to spectators. According to information in the Encyclopaedia Britanica (1978):

The Federation International de Football Association (FIFA) has more members than the United Nations. Its membership was brought to 135 at 1970 congress, compared with 126 in the UN. It is estimated that 600,000,000 to 1,000,000,000 people followed the 1970 World Cup in Mexico by television and radio. These facts are striking evidence of the tremendous popularity of the game, both as a participating sport and an entertainment (p. 210).

Nearly 20 billion spectators viewed the 1978 World Cup for the whole tournament (Miller, 1978), and more than 2 billion fans watched the final game (about half the population of the world

shared one event), a record that holds up to date (Lever, 1983). The 1982 Soccer World Cup was the first to be broadcast by network television in the United States, an indication of its growing popularity and participation in this country.

Association football is one of the pre-eminent sports on a world-wide basis and merits more than passing attention. This study was an attempt to investigate selected physiological and psychological characteristics of the Kuwaiti National Soccer Team which participated in the 1982 World Cup Championship.

The literature reviewed for the present study was divided into four general categories:

1. Literature related to maximal oxygen consumption (maximal aerobic power) and performance;
2. Literature related to anaerobic power and performance;
3. Literature related to body composition and somatotype and their relation to performance;
4. Literature related to psychological characteristics and high level performance.

#### Maximal Oxygen Consumption ( $\dot{V}O_2$ max)

In general, there is a paucity of research literature concerning the characteristics of soccer athletes, especially that related to world class players. Cardiovascular-respiratory endurance is vital for a soccer player to perform skills to the

best of his ability throughout an entire match, to be less susceptible to injury, to ensure confidence in himself, and to sustain a higher intensity of play for longer periods (Van Wieren, 1978). Performance in athletic competition has been measured either objectively (time or distance), or by subjective judgment (as in gymnastics and figure skating). To evaluate quantitatively the influence of various factors such as training and environment upon performance in different sports, and to examine how these factors relate to sex, age, and body size, scientists have begun systematic research, particularly related to energy output by aerobic processes.

#### Training and $\dot{V}O_2$ max

$\dot{V}O_2$  max is defined as the highest  $\dot{V}O_2$  that can be attained by an athlete performing work at sea level (Åstrand & Rodahl, 1977). The individual  $\dot{V}O_2$  max is mostly determined by natural endowment. However, regular training, in most cases, can increase the  $\dot{V}O_2$  max 10 to 20% (Åstrand & Rodahl, 1977), and it improves as much as 37.7% in special cases (Hickson, Bomze, & Holloszy, 1978).

Several investigators (Bryntenson & Sinning, 1973; Cabrera, Smith, & Byrd, 1977; Cureton, Sparling, Evans, Johnson, Kong, & Purvis, 1978; Fahey, Akka, & Rolph, 1975; Gettman, Ayres, Pollock, & Jackson, 1978) have shown the training effect of sport on  $\dot{V}O_2$  max in both absolute and relative terms. Sharkey (1979) stated

that smaller subjects generally have a higher level of aerobic fitness relative to body size, an important consideration in comparing soccer players to other athletes. Wilmore, Royce, Girandola, Katch, and Katch (1970) showed an increase of 3.6 to 9.9% in relative  $\dot{V}O_2$  max in subjects who jogged 12 or 24 minutes a day for 10 weeks, three days a week. Kasch and Wallace (1976) revealed no change in  $\dot{V}O_2$  max for subjects with an average age of 45 years, running, swimming, or performing a combination of both exercises over a ten year period. In another study in which the average training intensity was about 86% of maximal physical working capacity and the average duration was 59 minutes a day, three times a week, as the intensity of the training program increased,  $\dot{V}O_2$  increased in a comparable fashion (Hickson, et al., 1978). The Indian National basketball players, after four weeks of vigorous training camp, showed a significant increase in  $\dot{V}O_2$  max (Verma, Mahindroo, & Kansal, 1978). However, five of the 15 subjects revealed a decrease in  $\dot{V}O_2$  max, suggesting a deterioration due to overtraining. Cabrera, et al. (1977) attributed a 7.7% increase in relative  $\dot{V}O_2$  max during a basketball season to a decrease in body weight rather than to an increase in the functional capacity of the cardiovascular system of Puerto Rican basketball players.

### $\dot{V}O_2$ max in Athletes

Highest relative  $\dot{V}O_2$  max values of athletes, 81.5 (5.38 liters/min) and 81.7 ml/kg·min<sup>-1</sup> (5.88 liters/min), were reported by Robinson, Edwards, and Dill (1937) and Åstrand (1955) respectively. Saltin and Åstrand (1967) studied the  $\dot{V}O_2$  max of athletes in different sports, the highest absolute value being for cross-country skiing, 6.17 l/min (70.9 ml/kg·min<sup>-1</sup>).  $\dot{V}O_2$  max of 4.54 l/min (71.4 ml/kg·min<sup>-1</sup>) for marathon runners was reported by Costill and Fox (1969). Apparently, despite great differences in body size of athletes in these two sports, the relative metabolic demands are similar.

Faris, Gilley, Dean, and Teh (1980), on the other hand, reported a  $\dot{V}O_2$  max 57.57 ml/kg·min<sup>-1</sup> for decathlon athletes in training which was only 1.42% lower than the value obtained by Raven, Gettman, Pollock, and Cooper (1976) on professional players of the North American Soccer League. The soccer players were shorter, lighter in body weight, and higher in  $\dot{V}O_2$  max (58.4 ml/kg·min<sup>-1</sup>) than professional American Football players. Withers, Roberts, and Davies (1977) found that runners and race walkers had higher  $\dot{V}O_2$  max than soccer athletes, there were no differences between hockey and soccer players, and the lowest scores among the groups studied were by basketballers. A comparison between rowers, water polo, swimmers, and soccer players, (Novak, Bestit,

Mellerowicz, & Woodward, 1978) indicated that the rowers achieved the highest  $\dot{V}O_2$  max ( $62.2 \text{ ml/kg}\cdot\text{min}^{-1}$ ), whereas soccer athletes achieved the least ( $53.2 \text{ ml/kg}\cdot\text{min}^{-1}$ ).

If it can be assumed that  $\dot{V}O_2$  max of athletes reflects the metabolic demands of their sports, then athletes in team sports would appear to be less dependent upon aerobic capacity than are runners, skiers, and swimmers. In those sports reported here, soccer players'  $\dot{V}O_2$  max relative to body size was little different from that of athletes in other team sports.

#### Selected Factors Affecting $\dot{V}O_2$ max

In evaluation of  $\dot{V}O_2$  max of athletes, it is essential to select a work situation which is closely related to the individuals' specific sport activity. Stromme, Ingjer, and Meen (1977) found that skiers had a significant higher  $\dot{V}O_2$  max during uphill skiing than during treadmill running, and cyclists reflected large variance in  $\dot{V}O_2$  max between cycling and running, cycling being significantly higher. A significantly lower  $\dot{V}O_2$  in maximum swimming than in maximum running was found in the female and male elite swimmers performing maximum running on a treadmill and maximum swimming in a swimming flume (Holmer, Lundin, & Eriksoon, 1974).

With increase in altitude,  $\dot{V}O_2$  max decreases progressively and in a somewhat linear fashion (Pugh, 1964). A 1.5 to 3.5%



reduction in  $\dot{V}O_2$  max is expected for every 305 m above 1524 m altitude (Faulkner, Kollias, Favour, Buskirk, & Balke, 1968). McArdle, Katch and Katch (1981) stated that little protection is offered from this effect even when physical conditioning is done prior to altitude exposure.

$\dot{V}O_2$  max varies with different body temperatures. With progressive reductions in the core and muscle temperatures, the  $\dot{V}O_2$  max decreases accordingly (Bergh & Ekblom, 1979). Athletes are less negatively affected in aerobic power than non-athletes when exposed to a hot environment (Bergh & Ekblom, 1979).

Byrd and Collins (1980) showed a significant negative correlation between  $\dot{V}O_2$  max and age, % fat, total skinfolds, diastolic blood pressure, and weight. The excess weight imposes extra stress on the cardiovascular system during exercise. Although the mechanism is not clear, the athlete with elevated diastolic pressure is apparently at a disadvantage in endurance activity as shown by the negative correlation between  $\dot{V}O_2$  max and diastolic blood pressure.

The treadmill and the cycle ergometer are extensively used to measure  $\dot{V}O_2$  max in the evaluation of cardiovascular respiratory fitness of athletes. Both have specific advantages and disadvantages. The cycle ergometer is used for its simplicity, ease of movement from one place to another, independence of

electrical power, advantage in obtaining good quality ECG tracings, and the fact that the mechanical efficiency is independent of body weight (Åstrand & Rodahl, 1977). The treadmill, however, is preferable in situations in which it is important that body weight be a factor. Åstrand and Rodahl favored the cycle ergometer in submaximal exercises and the treadmill for the maximal exercise test. A variety of protocols (Åstrand, 1960; Balke & Ware, 1959; Bruce, Blackman, & Jones, 1963; Ellestad, Allen, Wan, & Kemp, 1969; Taylor, Buskirk, & Henschel, 1955; Taylor, Wang, Rowell, & Blomquist, 1963) are available for the two modes of testing. Pollock, Bohannon, Cooper, Ayres, Ward, White, and Linnerud (1976) found generally high correlations in  $\dot{V}O_2$  max among four protocols (Balke & Ware, 1959; Bruce, et al., 1963; Ellestad, et al., 1969; & the Modified Åstrand test, Åstrand & Rodahl, 1977). The Taylor protocol has been shown to yield a higher  $\dot{V}O_2$  max than either the Bruce or Balke protocols (Froelicher, Brammell, Davis, Noguera, Stewart, & Lancaster, 1974).

It is, therefore, important that  $\dot{V}O_2$  max values are examined critically with respect to these miscellaneous factors that might have some influence. It is probably particularly important that exercise mode and protocol be scrutinized carefully prior to comparing outcomes of different studies.

### Anaerobic Power

Anaerobic power is a critical factor for success in performance of athletes participating in the majority of competitive sports. Wilmore (1977) stated that:

It is suspected that a highly developed anaerobic power, or capacity, is related to the ability to maintain the maximal running velocity or to perform repeated runs up and down the court or field, without substantially decreasing the quality or speed of the runs (p. 91).

McCloy and Young (1954), defined power as the "capacity of the individual to bring into play maximum muscle contraction at the fastest rate of speed". Physicists express power as work performed over a period of time, with work being the product of force and the distance over which the force is applied. Therefore,  $Power (P) = Force (F) \times Distance (D) / Time (T)$ . From this power formula, two components can be identified: (1) F, a function of strength, and (2) D/T, or speed. To develop power, anaerobic speed training and weight training are highly recommended (Wilmore, 1977; Clarke, 1978; Moulds, Carter, Coleman, & Stone, 1979). While speed is a chief component of power (Considine & Sullivan, 1973; Start, Gray, Glencross, & Walsh, 1966), muscular strength (McClements, 1966; Costill, Millers, Myers, Kehoe, & Hoffman, 1968) and efficiency of the ATP-PC system (Saltin, 1973; MacDougall, Ward, Sale, & Sutton, 1977) also play

major roles. Since speed is less susceptible to change, most increases in power must come from development of strength. Therefore, training with weight is a method commonly used to develop power.

#### Training and Anaerobic Power

Stone, Byrd, Tew, and Wood (1980) found a significant improvement in power in thirteen non-experienced Olympic weightlifting performers across time. The training program consisted of free weight exercise, three days a week for fourteen weeks. Measurements were obtained at the beginning of the training period, at the end of the seventh week, and at the end of the training period. This supports the findings of Ness and Sharos (1956) in which they formed an experimental and a control group of 30 college basketball players. The experimental group participated in progressive weight training, three days a week, for four weeks. In addition to an increase of 3.23 inches in vertical jump of the experimental groups, a significant increase in strength was also obtained. Most recently, O'Bryant (1982) found a significant simultaneous increase in strength and power throughout several experiments on weight training. It was concluded that a theoretical model of training, based on the concept of periodization, was superior to traditional methods for increased strength and power achievements, particularly for

achieving peak performance at specific times.

Progressive weight training of localized muscle groups and its contribution to vertical jump distance were studied by Bangerter (1968). Twenty college students were assigned to four groups: 1) ankle plantar flexors; 2) knee extensors; 3) hip extensors and; 4) all three exercises. A control group of twenty subjects were also studied. Each experimental group exercised three times a week for eight weeks. One set of 8 - 10 repetitions to maximum were performed at each exercise session. Three exercise groups improved significantly in strength. The investigator concluded that knee extensors, hip extensors, and combination of the two contributed to improvements in both strength and vertical jump. Very little contribution, if any, was obtained by the plantar flexors, suggesting that they may act as positioners and resistors to the forces superimposed upon them by the other groups.

Clearly, power can be modified through improvement of muscular strength. While strength gains can be obtained in other ways, training with weights appears to be the most common mode for those seeking to improve power through better strength.

McKenzie, Parkhouse, Rhodes, Hochochka, Ovalle, Mommsen, and Shinn (1983) found the acid buffering capacity of the skeletal muscle significantly greater in anaerobically trained elite

runners than in aerobically trained and sedentary subjects. No difference was found between aerobically trained and untrained subjects, in agreement with the work of Sharp, Armstrong, King, and Costill (1983).

McArdle, et al. (1981) summarized the metabolic changes following anaerobic training as increases in anaerobic substrate levels, increases in the amount and activity of enzymes involved, and increases in maximum blood lactate levels. The physiological and biochemical changes responsible for lowered lactate production at a standard load are produced by lower power output training programs (Fox, Bartels, Klinzing, & Ragg, 1977).

#### Power and Source of Energy

The dominant energy source in the initial seconds of the anaerobic power process is the ATP-PC system (MacDougall, et al., 1977). In heavy exercise, with a duration of only few seconds, ATP-PC utilization starts at the onset of exercise, with glycolysis contributing before ATP-PC is completely depleted (Saltin, 1973). Margaria, Cerretelli, and Mangili (1964) emphasized the point that glycolysis begins only after almost all ATP-PC has been depleted.

Soccer players often run with short bursts of speed in their attack on the opponent or in defense of their goal from the opponent's offensive players. Evidence of the important

contribution of glycolysis was provided by Saltin (1973), who found that the initial level of muscle glycogen is important in the performance of intermittent work. He studied nine soccer players, five of whom who had a normal thigh muscle glycogen content ( $96 \text{ mmol glucose unit} \times \text{kg}^{-1}$ ) before the game, with the other four having only half of that level, having participated in exhausting work on the previous day. At half time, the five players with normal initial values of glycogen had  $32 \text{ mmol glucose unit} \times \text{kg}^{-1}$ , whereas the other group had practically no glycogen left in their thigh muscles. After the game, very low glycogen values were found for all players. The total distance run and the speed of running were determined by analyzing a movie that had been taken for each player during the game. Both groups revealed a reduction in the distance covered between the first half and the second half of the game. The players with highest glycogen content at the start of the game covered 25% more distance than the other group. A more pronounced difference was revealed in running speed. The players with normal glycogen content covered 27% walking and 24% sprinting compared with half the total distance walking and 15% sprinting for the players with low glycogen content. The importance of power to soccer performance and the contribution of glycolysis to power were clearly defined in this experiment.

### Measurement of Anaerobic Power

Several power tests have been developed. Johnson and Nelson (1979) distinguished two types of power measurements: (1) athletic power measurement, and (2) work power measurement. Athletic power measurement is expressed in terms of the distance through which the body or an object is propelled through space. The force and velocity factors are not measured, only the resultant distance being recorded. Such tests include the vertical jump, broad jump, and vertical arm pull. The work - power measurements are given in kg-meters per second or in kcal/kg per hour.

Power can be measured very accurately in the laboratory using expensive force transducers and recorders, or can be determined by field tests such as jumping or putting the shot or the medicine ball. A more objective test, specific to leg power, was developed by Margaria, Aghemo and Rovelli (1966) and modified by Kalamen (1968). The subject started 6 meters away from the first step of a set of stairs in order to build up maximum speed. Then the subject continued to run up three steps at a time. The time between the third stair and the ninth stair was recorded to the nearest hundredth of a second. The values recorded were then substituted in the formula:

$$\text{Power} = \text{Body weight} \times \text{vertical distance} / \text{time}$$



Such leg power measurements have been used almost exclusively as an indication of potential power, partly because of the difficulty of arm power measurements (Costill, 1974).

Another anaerobic test, using a cycle ergometer, was designed by Evans and Quinney (1981). A resistance (force) was selected and set to elicit the maximum power output over a period of 30 seconds. The cycle was modified to allow quantification of power produced. Thompson (1981) introduced a field test for prediction of anaerobic capacity of young healthy males. Based on intensity of exercise and time of performance, the prediction of anaerobic energy expenditure was obtained by means of sprint performances between 183 and 366 meters, and 20 to 30 and 50 to 60 seconds for the minimum and maximum test performance time.

Power measurements are very useful for predicting athletic success in power-related sports like soccer. Athletes were found to have higher levels of leg power than non-athletes (Margaria, et al., 1966). Further, the players that were most successful revealed higher power output than the less successful players.

#### Anaerobic Power and Sport Performance

Beckenholdt and Mayhew (1983) examined 50 male athletes from football, soccer, baseball, basketball, and wrestling, testing with the vertical jump, the standing broad jump, the Margaria-Kalamen test, and the 40-yard dash. Soccer athletes

revealed the lowest scores in the vertical jump, the standing broad jump, and the Margaria-Kalamen test, but had the highest score in the 40-yard dash. Football players ranked highest in all except the dash. This may be due to the fact that the game of football is characterized by a greater anaerobic energy requirement, while soccer combines both anaerobic and aerobic demands. In support of this, DiPrampero, Pinera-Limas, and Sasi (1970) found in olympic athletes the highest maximal anaerobic power in pentathletes, followed by sprinters and middle-distance runners. Swimmers and hockey players had the lowest values, while soccer and rowing athletes fell in the middle with respect to maximal anaerobic power.

Withers, et al. (1977) studied the anaerobic power of South Australian male representatives in soccer, hockey, basketball, running, and walking. Soccer players possessed higher anaerobic power in both absolute and relative values, followed by hockey and basketball, with the runners and walkers being the lowest. In contrast, Verma, Mahindroo, and Kansal (1979) obtained higher absolute anaerobic power for National Indian basketball players than for young National Indian soccer athletes. However, the relative anaerobic power values for the Indian soccer players were higher than for the basketball players.

There are position-dependent differences within specific

sports. Costill, Hoffman, Kehoe, Miller, and Myers (1968) concluded that successful college football players can be characterized by their anaerobic power output. They also revealed significant differences in anaerobic power between players of different positions, the tackles, centers, and guards having the highest anaerobic power. Ends and inexperienced players developed the least power. Soccer players were also found to have different maximal anaerobic power according to their positional role. Caru, Le Coultre, Aghemo, and Pinero-Limas (1970) and Verma, et al. (1979) reported the defensives and the midfield players as the second highest groups to goalkeepers, followed by the offensive players.

The literature clearly indicates that anaerobic power is an important fitness component for soccer players. While there appear to be differences by position within the sport, it is obvious that aerobic power, skill, and other factors contribute to success, since in comparisons of anaerobic power across sports, soccer players are consistently located around the mean for athletes in general.

#### Body Composition\* and Somatotype

##### Body Composition

Information from evaluation of body composition (% body fat and lean body weight) can contribute to more scientific

development of training for a particular sport (Wilmore & Haskell, 1972). These data can also aid in understanding of the ultimate physical and physiological capacities and limitations of athletes in sports. Athletes generally have body composition characteristics that are unique to their specific sport. For example, long distance runners have small amounts of lean body weight and fat weight, whereas field-event athletes have much large quantities of lean tissue and a relatively high per cent of body fat (McArdle, et al., 1981).

Estimation of per cent body fat (% fat) is based on body density evaluation. One way to measure body density in man is to apply the Archimedes principle of water displacement. Several investigators (Goldman & Buskirk, 1961; Harsha, Frerichs, & Berenson, 1978; Katch, Michael, & Horvath, 1967) have used densitometric techniques of under water weighing. These are relatively inexpensive and consist of portable, in-water equipment. Other techniques that are more valid, but are time-consuming, costly, and require expensive, delicate, and immobile equipment, include potassium 40 and other dilution methods, creatine excretion, and gas displacement. Other procedures involve measurements of surface area, skinfold thicknesses, circumferences, ponderal index, and diameters, in addition to the height and weight of the individual (Durnin &

Rahaman, 1967; Forsyth & Sinning, 1973; Jackson & Pollock, 1978; Pascale, Grossman, Sloan & Frankel, 1956; Sloan, 1967; Wilmore & Behnke, 1969).

Several investigators used various of these methods to evaluate body composition of athletes in various sports. Burke, Winslow, and Strube (1980), Smith and Byrd (1976), and Wilmore and Haskell (1972), revealed 18.3, 13.7, and 14.4 per cent body fat respectively for American football players. Bell (1980) and Maud (1983) found 14.6 and 12.0 per cent fat for rugby players. American football and rugby are similar in that they are both contact sports. In such sports, higher values of relative fat deposits limit injuries because of the cushioning effect that such tissue provides. Costill, Bowers, and Kammer (1970), Costill and Fox (1969), and Pollock, Jackson, and Pate (1980) reported lesser values for marathoners (7.5, 4.6, and 5.6 respectively), athletes to whom excess fat would clearly impose a penalty. Soccer players, on the other hand, were characterized by 9.6 per cent body fat, suggesting that soccer requires less body fat than football, and somewhat more than the marathon to balance the aerobic endurance requirement and meet the demands of the game (Raven, et al., 1976). Runners (Pollock, Miller, & Wilmore, 1974) between 40 and 75 years of age had an average of 11.8 per cent fat, perhaps reflecting the training effect on body composition

regardless of age and specific sport.

Withers, et al. (1977) reported mean body fats of 16.6, 16.7, and 15.7 per cent for basketball, hockey and soccer players, showing no significant differences between the three classes of performers. A lower mean value of 13.1 per cent was obtained for runners and race walkers. Novak, et al. (1978) found no difference in per cent body fat between water polo players, swimmers, rowers, and soccer players (8.8, 7.5, 7.3, and 6.2 respectively). However, when total body fat was expressed in absolute terms, water polo players showed a significantly higher value (7.2, 5.6, 6.5, 4.5 kg respectively). Wilmore, Royce, Girandola, Katch, and Katch (1970) reported changes in body composition from a 10-week jogging program. The alterations that occurred were a reduction of total body weight and unchanged lean body weight, indicating a loss in total body fat. The amount of body fat loss appears to be due to the balance between caloric intake and caloric expenditure, more related to exercise duration than intensity (Swenson & Conlee, 1979). Body composition is also altered significantly as a function of the frequency of participation (Pollock, Cureton, & Greninger, 1969). That is consistent with the concept that total caloric expenditure is a critical factor (Swenson & Conlee, 1979).

Training by athletes expends large numbers of calories and so

contributes to maintenance of a relatively low per cent body fat. The degree to which selection is a factor in participation by individuals with particular fatness characteristics in specific sports that reward that makeup is unknown at this time.

### Somatotype

Physical appearance and body structure are of common interest to athletes, coaches, and researchers. Categories have been formed on the basis of skinfolds and girth measurements, casual observations, and photographic analysis (Leslie, Byrd, & Collins, 1977). The specific terms endomorph (obesity), mesomorph (muscularity), and ectomorph (thinness) that were introduced by Sheldon (1954) are generally the most accepted description of physique.

In determining the body build classification, or somatotype, the individual is scaled from 1 to 7 in each component. The somatotype is thus given in a three-number sequence in which the first number represents an endomorphic component; the second, mesomorphy, and the third, ectomorphy. An extreme mesomorph is a 1-7-1; and an extreme ectomorph is a 1-1-7 (Johnson & Nelson, 1979, p. 172)

Hirata (1966) described the physique and age of Tokyo Olympic champions of different countries, suggesting that the countries whose people's physique is generally limited to the characteristics of champions in certain events should concentrate

on those events. Hirata stated that the small built Japanese has a better chance for champion performance in gymnastics, long distance running, the light class in boxing, weight lifting and judo, equestrian sports, and long distance cycling. Differences in physique and body size are striking among some elite participants in various sports, thus suggesting that somatotype is a strong determinant of championship performance (Carter. 1970).

Several researchers have revealed that the players in different sports have different body size, shape and composition according to the demands of the various sport events (Behnke & Royce, 1966; Gray, 1936; Hirata, 1966; Sidhu, Kansal, & Kanada, 1975; Withers, et al., 1977). Greater than average mesomorphy is required for almost all athletes; the degree to which endomorphy or ectomorphy is developed as the secondary component is quite variable and specific to various sports.

Kansal, Verma, and Sidhu (1980) found that forward and stopper soccer athletes (defensives) have similar body proportions, but different individual body measurements, except for skinfold thicknesses. This may indicate that these body proportions have a common benefit for the forward and the stopper players. Players of both positions require speed, power, and agility, but forwards are more continuously active. Durnin and Rahaman (1967) showed that forwards have slightly greater



cumulative diameters and circumferential scores in relation to their body weight and height. Kansal, et al. (1980) also showed that a forward player has narrower hips and broader femur, with a larger thigh and calf. This, according to biomechanical laws, gives less angular reaction to the forward stride which improves running efficiency (Metheny. 1939). Rowers and water polo players have significantly larger skeletal width and length measurements than soccer players, particularly in the upper body (Novak, et al., 1978), illustrating the theme of somatotype-to-sport matching.

Elite distance runners were muscular but were characterized as being more ectomorphic than most athletes. Basketball players were tall and lean. In addition to height, technique and strength, anaerobic power is more pronounced (Cabrera, et al., 1977). While distance runners were not as tall as the basketball players, both have similar profiles in leanness. Endurance and strength are the most important fitness elements in distance running. A third group, the endo-ectomorphic group that consisted of judoists, football players, U.S.S.R. gymnasts, weightlifters, and wrestlers can be classified as being large and stout. Weight lifters showed the stoutest physique, followed by the wrestlers and the judoists (Hirata, 1966).

Various sports and events appeared to reward different body

physiques. To achieve the highest possible level of performance, acquiring the physique characteristics of a certain event therefore is crucial. Further, Hirata (1966) showed constitutional variations among athletes of different countries as well as continents. He revealed that Asians in general were small in development with most being lean and a few others more stout. Europeans were large and stout, whereas, Africans were as small as Asians with the champions tending to be lean.

#### Psychological Characteristics and Performance

##### Training Effect

Physical activities revealed positive psychological values for healthy individuals (Brunner, 1969; Mann, Garrett, Farhi, Murray, & Billings, 1969; & Morgan, 1968), as well as cardiac (Naughton, Bruhn, & Lategola, 1968) and psychiatric (Morgan, 1968) patients participating in various exercise and activity programs.

Morgan, Roberts, Brand, and Feinerman (1970) evaluated the interrelationships of depression, age, height, weight, % fat, grip strength and physical working capacity in 67 normal adult men. A low correlation between depression and physical working capacity was reported. They also studied 101 adult males assigned to five groups involved in an exercise program which consisted of circuit training, jogging, swimming, treadmill running and cycling on an ergometer. Sixteen subjects served as a control group. The

training period was for six weeks, each session lasting 55 minutes. No significant reduction in depression for any of the groups was found after six weeks of training. However, a significant reduction in depression was observed in the subjects that were initially depressed. This finding appears to be in agreement with the common belief that exercise somatotherapy is able to improve psychological states (Morgan, 1969). In contrast, Thaxton (1982) found significantly lower depression on the Profile of Mood States (POMS) in normal healthy male and female runners than in a non-running group. Blumenthal, Williams, Needels, and Wallace (1982) found that after 10-weeks of aerobic exercise, psychological states were enhanced significantly. Sixteen male and female subjects were assigned to a 10-weeks continuous walking or jogging exercise, three times a week. The psychological instruments used in the study were: Profile of Mood States (POMS), State-Trait Anxiety Inventory (STAI) and Retrospective Change Questionnaire. They found that the exercise group experienced reductions in both state and trait anxiety, felt less tense, depressed, fatigued and confused, and more vigorous than did the control group. Significant reductions in state and trait anxiety were also observed after 14 weeks of aerobic conditioning (McGlynn, Franklin, Lauro, & McGlynn, 1983).

The interactive effects of trait anxiety and stress on motor

performance were explained by Weinberg and Ragan (1978). Three levels of trait anxiety were selected. Thirty high trait anxious, 30 moderate anxious, and 30 low anxious subjects were selected after the initial Trait Anxiety Inventory (Spielberger, Gorsch, & Lushene, 1970) was administered to 420 males. The task was to throw tennis balls overhand at a target comprised of three concentric circles. After throwing the first 10 balls, the subjects were randomly assigned to high stress, moderate stress and low stress feedback statements. The second state-anxiety questionnaire was conducted, followed by the second trial of throwing the 10 balls. The results of the performance revealed that the moderate-stress condition displayed the highest performance. Trait anxiety and stress interaction indicated that high trait-anxious subjects performed best in the low-stress condition, whereas low trait-anxious subjects performed best in the high-stress condition.

#### Psychological Characteristics of Athletes

Male athletes within a sport are generally fairly similar, anatomically. Their muscular-skeletal, and cardiovascular-respiratory systems are similar. Physical differences such as size and strength which individualize the athletes, are manipulated through physical practices and by selection for a particular sport's demands. Likewise, the mind of

the athlete is treated the same way.

The human mind is structurally similar among persons, and individual psychological differences such as self-esteem, intelligence, and need for achievement distinguish us. It is possible that manipulation of these individual differences could enhance athlete performance. Psychological techniques analogous to weight training and wind sprints are needed that will improve athletic performance and that can be generalized to many athletes (Taylor, 1981, p. 88).

The anatomical and physiological characteristics related to success sometimes appear to be limited in some athletes in spite of their very high level performance. This paradox is often attributed to psychological factors within the athletes such as drive, desire, persistence and determination. Conversely, athletes with deficiencies in these psychological characteristics, but with very high levels of performance succeed primarily because of their superior anatomic and/or physiological makeup. Therefore, physical or psychological factors alone would not be sufficient to predict success in a highly reliable manner. Ideal prediction can only be done by viewing the athlete as a complex psychophysiological organism.

In selecting, counseling, and training athletes, sport scientists are concerned with physiologic and psychic characteristics. Thomas, Zebas, Bahrke, Araujo, and Etheridge

(1983) found that in distance runners, 81% of the variance related to success was contributed by the physiological factors. However, 80% of the variance related to successful sprinting and jumping was attributed to a combination of the physiological and the psychological factors.

The psychological characteristics of another group of endurance runners showed different results. Morgan and Costill (1972) reported no significant correlation between extraversion, neuroticism, anxiety and depression, and marathon performance. They showed that marathon runners were introverted. Conversely, Morgan and Pollock (1977) revealed that elite American marathon runners were not introverted. Both studies characterized the runners as being significantly less anxious and less depressed than the normal population. American cyclists on a National level were also characterized as being introverted (Hagberg, Mullin, Bahrke, & Limburg, 1979).

Extraversion, on the other hand, was characteristic of the Olympic wrestlers (Morgan, 1968). Wrestlers with low extraversion failed to qualify, and were eliminated early in the tournament, whereas wrestlers who advanced to the next rounds and competed for the championships were high in extraversion. Moreover, self confidence, and ability to focus attention were found to separate the successful college wrestlers from the unsuccessful (Gould,

Weiss, & Weinberg, 1981).

There is very little literature on psychological characteristics of soccer players, although it is the world's most popular sport in terms of participation and spectator appeal. Reid and Hay (1979) examined the behavioral characteristics of rugby and soccer players and found that although there were no differences in personality and achievement oriented behavior, rugby and soccer players were significantly different in aggression and attitudes toward physical activity.

Thakur and Ojha (1981) compared personality differences between table-tennis, badminton, and football (soccer) players. Soccer players appeared to differ in several factors of the 16 PF questionnaire from the other two groups (Kroll & Peterson, 1965). Athletes' personality characteristics were happiness, cordiality, affectionate, anxious, achievement-oriented, dominant, and with superior organizing capacity. Non-athletes were characterized as passive, rejected, with guilt feelings, acquisitive, imaginative and interested in sex (Thakur & Thakur, 1980).

The mental state of the athlete differs in practice from in competition. Therefore, attention has been focused on preparing athletes psychologically for competition. Morgan (1974) in an attempt to explain the psychological characteristics of athletes of various sports and their preparation for competition,

determined five concepts to be used by coaches, trainers, physical educators, and physicians in the area of sport medicine. The concepts which were developed consist of (1) knowing the psychological profiles of various sport groups, (2) understanding the psychological characteristics of successful versus less successful athletes, (3) use of individualization in handling tension states of athletes, (4) understanding mental health and its important role in sport, and (5) understanding of the athlete's conscious and unconscious behavior and motives. Psychological preparation of athletes for competition was divided into general and special procedures (Blumenstien & Hundanov, 1980). Both general and special preparations should exist on a daily basis during training sessions, with more attention being directed to special preparation as time to competition nears. Three stages have been suggested by Gurov, Svyadoshch, and Tampolsky (1980) for preparing athletes psychologically for competition. The first two stages, the initial auto suggestive training and the positive sensory hallucination training, were preparatory and common to athletes in various sports. The third stage, the goal-directed training stage, should account for the competitive specificity of each event.

Managing the psychological characteristics of the top athletes is a complex procedure. Salmela, Hosek, Janssen,



Pilvein, and Silva (1979) explained the various problems that the sport psychologist will encounter in managing psychological states of the top athletes, such as differences in the athlete's acceptance of intervention by the sport psychologist. They also reported that certain unbalanced combinations of aggression, aloofness, and emotionality may be prerequisites for high level performance. An example given was that the Brazilian soccer players who were very good, sometimes revealed neurotic behavioral states, while the players who had balanced psychological characteristics were not the best players. Emphasizing the essential role of the sport psychologist in concert with the coach, athlete, and team physician, Salmela and his colleagues (1979) stated that "The roles of mediator in moments of conflict as well as a technician in reduction of the competitive anxiety seems to recur most frequently." (p. 163). Despite much progress in dealing with elite athletes, Morgan (1979) and Salmela, et al. (1979) suggested a conservative approach in prediction of performance by the sport psychologist. Moreover, Morgan (1979) warned coaches to be reasonable in the requests they make of sport psychologists. Psychological attributes are only part of the puzzle of performance that must be solved.

#### Anxiety - State and Trait

Anxiety in sport competition is one of the few subjects that

sport psychologists have investigated widely. However, we are far from thoroughly understanding the role of anxiety in sport competition. Hogg (1980) related the completely unconvincing results to the measuring instruments being too general and unreliable, failure to distinguish between the enduring trait and transitory state anxiety, and to the fact that most research occurred in an artificial competitive situation.

It is widely accepted that both state and trait anxiety play important roles in individuals' performance in sports. Sanderson and Ashton (1981) reported that the effect of state-trait anxiety is not unidirectional, but rather that it may be adapted to the inverted-U hypothesis. Hence, intermediate levels of arousal are generally considered to produce optimal performance (Sonstroem & Bernardo, 1982).

In threatening situations, anxiety can best be effectively manipulated when one's self-esteem is directly affected (Hodges, 1968; Hodges & Spielberger, 1969). Morgan (1970) found lower anxiety levels in varsity wrestlers prior to a match than at preseason scores. Subsequent studies (Morgan & Hammer, 1974; Martens, & Gill, 1976) indicated higher state anxiety levels at precompetition and mid competition than under normal conditions. Post competition state anxiety levels were obtained in basketball players (Gruber & Beauchamp, 1979), badminton players (Sanderson &

Ashton, 1981), and cross country runners (Sanderson & Reilly, 1983) and indicated that the level of state anxiety reduction in post-competition was greater after winning matches than after losing. Huddleston and Gill (1981) indicated that state anxiety level were shown to increase as time to competition neared.

Female basketball players were significantly more anxious before the crucial games than before the easy games (Gruber & Beauchamp, 1979). They also revealed a significant reduction in anxiety state after all winning games, while state anxiety remained high after the games were lost.

The role of skill and experience as mediators in the performance-anxiety relationship has been reported (Carron, 1971; Griffiths, Steel, & Vaccaro, 1979). Increased confidence (less anxiety) is characteristic of both the highly skilled and the experienced athlete.

Mahoney and Avenier (1977) reported differences in arousal patterns as a function of skill level in male gymnasts. Further, they found Olympic qualifiers to have slightly higher anxiety than nonqualifiers prior to competition. The nonqualifiers, however, revealed higher anxiety during performance. The complexity of the anxiety-performance relationship is obvious.

Fenz and Jones (1972) studied anxiety in parachutists and found that the best performers showed an increase in arousal early

during the jump sequence, with sharp decreases in arousal upon exiting from the aircraft. In addition to general experience, repeated exposure to a specific stressor also was found to be effective in dealing with stress. Powell and Verner (1982) supported the findings of Fenz and Jones (1972) and reported individuals who chose to participate in parachuting had low trait anxiety.

Relaxation techniques appear to have positive effects on anxiety and performance. Griffiths, Steel, Vaccaro, and Karpman (1981) obtained significant differences between a control group and two relaxation groups (a meditation and a biofeedback group) on state anxiety following relaxation training. Nideffer and Deckner (1970) reported an improved performance in shot-putting after progressive relaxation prior to competition. The efficacy of relaxation, however, might be dependent on the state of arousal, if one accepts the inverted-U hypothesis.

#### Profiles of Mood States (POMS)

Profiles of Mood States (POMS) was developed by McNair, Lorr and Droppleman (1971) to measure six mood or affective states: Tension-Anxiety; Depression-Dejection; Anger-Hostility; Vigor-Activity; Fatigue-Inertia; and Confusion-Bewilderment. Normative data as well as psychiatric outpatients' norms have been introduced. Normal healthy individuals, psychiatric, and cardiac

patients, as well as athletes in various sports and events have been subjected to POMS investigations.

Blumenthal, et al. (1982) reported less tension, fatigue, depression, and confusion, and less vigorous characteristics in normal healthy males and females who exercised for 10 weeks than the non-exercised control group. Athletes in general have been characterized as being less tense, depressed, angry, fatigued, and confused and more vigorous than the normal population (Morgan & Pollock, 1977; Thaxton, 1982; Thomas, et al., 1983). National American cyclists showed similar profiles except for the fatigue factor (Hagberg, et al., 1979), which was not lower than the normal values. Silva, Shultz, Haslam, and Murray (1981) found that high state anxiety and tension, but less depression, anger, viciousness, fatigue, and confusion were the characteristics that discriminated the elite qualifiers from the non-qualifying wrestlers of the 1979 United States Junior Camp.

Researchers have debated the question of which psychological inventory to employ for some time (Morgan, 1979). The argument was concentrated upon whether to use the ones that are designed to measure traits or others that measure states, whereas a third party prefers state-trait models. Morgan (1979) suggested that the best inventory to apply is the one that is governed by the question being asked in any given situation. Various inventories

such as the Eysenck Personality Inventory (EPI) (Eysenck & Eysenck, 1968), Profiles of Mood States (POMS) (McNair, et al., 1971), and the State-Trait Anxiety Inventory (STAI) (Spielberger, et al., 1970) have been designed to measure various psychological traits and/or states.

#### Statement of the Problem

This study was undertaken in order to describe the maximal oxygen consumption, maximal anaerobic power, body composition, somatotype, and selected psychological characteristics of the Kuwaiti World Cup male soccer athletes.

#### Delimitations

1. Kuwaiti National Soccer Team constituted the subject population. Generalization was therefore limited by this one team sample.

2. Maximum oxygen consumption, maximum anaerobic power, body composition, somatotyping and selected psychological characteristics were the only parameters investigated.

#### Basic Assumptions

The following assumptions were made for the study:

1. Each subject put forth his maximum effort in the exercise testing.

2. Translations from English to Arabic for psychological testing were precise, but meaningful, resulting in the items and

the entire test being valid for this group of athletes.

#### Significance

Investigation of selected characteristics of world class athletes will provide more basic information to coaches and athletes who are naturally concerned with improving the status of their particular sport. Much of the rapid and marked advance in sport performance over the past two decades has been the result of application of findings by sports scientists. Yet, one of the major problems that coaches still encounter in selecting players for high-level performance is the lack of objective measures. Soccer coaches commonly select players by subjective evaluation of their players' performance in competition.

This investigator's intention was to identify some of the factors that might help solve this practical problem of validating potential ability, especially as related to world class level. Further, the results of this study should be of value in seeking explanations for sub-par performances and in planning procedures for remediation.

Aerobic and anaerobic power have been found to be critical to success in various sports, as are both body composition and physique. The degree to which these elements interact with performance in soccer is not well known at this time. Although direct physical and physiological assessments have seldom been

systematically used on elite soccer players, valid and reliable laboratory tests are available. Those tests could be useful in predicting an athlete's potential for success in soccer competition if a valid physiological and anthropometric profile were available.

Psychological states and traits also play an important role in sports. Athletes sometimes lack the optimal physiological standard for a particular level, but are found to perform very well. The explanation for their success in this case is usually attributed to psychological factors (Morgan, 1979). In high level performance when little difference exists in skill or physical characteristics, psychological assets are particularly valuable tools for the preparation of the athlete for competition, perhaps making the difference between winning or losing a soccer match.

Owing to the shortage of information about the physiological as well as psychological profiles of world class soccer athletes, this investigation will add specifically to the literature on this sport and may encourage others to follow the same path for future studies. The need is critical, this being one of the world's most popular sports among players and spectators, but one to which attention of scientists has not been appropriately directed.



## CHAPTER II

### MATERIALS AND METHODS

#### Subjects

Subjects were the members of the Kuwaiti National Soccer Team who competed in the 1982 World Cup championships. The subjects were informed of the nature of the investigation before the commencement of any tests and were asked to sign a consent form in accordance with the Human Use Committee at Louisiana State University.

#### Maximal Oxygen Consumption

$\dot{V}O_2$  max was measured using an Ergo-oxyscreen (Erich Jaeger, Appendix A) that determined the minute ventilation, breathing frequency, respiratory quotient, heart rate, oxygen uptake, carbon dioxide output, relative oxygen uptake, and oxygen pulse during maximal work. The Ergo-oxyscreen is a semi-open circuit device that is composed of subunits for measuring minute ventilation, respiratory gases and heart rate.

Expiratory flow is measured through a pneumotachograph which is integrated to the expiratory volume and assayed over 30 second periods. At the same time, the expiratory air is collected in a semi-open breathing bag from which a continuous sample is taken. The gas analysis for carbon dioxide is based on the infrared

absorption principle and the oxygen concentration is determined by the paramagnetic susceptibility of oxygen.

For heart rate measurements, electrocardiogram (ECG) electrodes were placed on the subjects, using lead V6 in order to get a good R peak. An external ECG amplifier which measures the R-R interval was used, with the resulting heart rate being fed to the evaluation unit of the instrument.

The evaluation unit consisted of a micro-processor for the acquisition and subsequent treatment of the accumulated data. It included a keyboard for input and control of the measuring process, displays for system communication, and a thermal printer.

All the calibrations were done under ambient temperature and pressure (ATP) conditions prior to each work bout. The minute ventilation calibration was done by connecting a one liter calibration pump to the breathing tube, with the zero adjustment being carried out automatically by the machine. The gas sample was dried before it entered the analyzer port. The absorbant was changed before each measurement to avoid pressure and resistance changes in the analyzer system. Gas analyzers were calibrated against standards provided by Sociedad Española Del Oxígeno, S.A.

Once the calibrations were complete, the subjects' number, age in years, height in centimeters, weight in kilograms, and the barometric pressure were fed to the evaluation unit via the

keyboard. Data were printed out every 30 seconds and any interruption of the breathing maneuver, such as loss of mouthpiece, caused the program to stop.

The subjects performed the max test on a cycle ergometer at 60 rpm, using a continuous protocol of graded exercise. The load started at 25 watts and was increased by 25 watts every minute until exhaustion. The criterion for actual achievement of  $\dot{V}O_2$  max was the occurrence of no further increase in  $\dot{V}O_2$  with increased work load.

#### Anaerobic Power

Vertical jump was measured using a special device developed for this study. The device consisted of a rectangular metal base with a retractable measuring tape attached to the center. The free end of the tape was then attached to a belt worn by the subject. Following readings at the standing position, three vertical jumps were made, the highest value being used in the calculation of power using the Lewis formula:  $(\sqrt{4.9 \times \text{weight} \times VD})$ , where D is equal to the vertical jump score.

#### Somatotype

Body type was determined by the modified Heath-Carter (1967) method, an anthropometric means of obtaining body type.

The first component rating (Endomorphy). Skinfolds were obtained with Lange calipers, with a caliper pressure of 10 grams

per  $\text{mm}^2$ , on the dominant side of the body at four sites. Measurements were taken in millimeters over the triceps, sub-scapular, suprailiac, and medial calf. Calculations were made for endomorphy from the sum of the first three.

The second component rating (Mesomorphy). Epicondylar humerus width was taken at  $90^\circ$  flexed elbow, and epicondylar femur width at  $90^\circ$  knee flexion, with the subject in a seated position. Measures were in centimeters, using spread calipers on the dominant side of the body. Height was measured using a stadiometer and a medical scale was used for weight. The largest upper arm girth around the flexed and tensed arm and the maximum standing calf girth, again on the dominant side of the body, was taken in centimeters using a cloth tape. These, along with triceps and calf skinfolds were used to calculate the mesomorphic component.

The third component rating (Ectomorphy). Weight in kilograms and height in centimeters were used to calculate the ectomorphic component.

Heath-Carter somatotype tables were used for rating all the three components to determine the anthropometric somatotypes (Carter, 1975). Somatocharts were used for comparison with other populations.

### Body Composition

Skinfold measurements were taken at the following sites:

1) Subscapular - fold running downward and laterally at about 30° to vertical from inferior angle of scapula; 2) abdominal - horizontal fold on anterior abdominal wall halfway from umbilicus to mid-axillary line; 3) chest - oblique fold on the line joining the anterior axilla halfway from nipple; 4) triceps - halfway of the upper arm between the acromium and the olecranon process on the dorsal side.

The formula of Forsyth and Sinning (1973) was applied for the determination of body density. The per cent body fat was computed to the equation of Siri (1956):

$$\% \text{ Fat} = (4.950/DB - 4.500) \times 100$$

Lean body weight was calculated by the following equation:

Body weight - weight of fat where fat weight is calculated by:  
fat weight =  $\% \text{ Fat} / 100 \times \text{body weight}$ .

### Psychological Testing

Translated versions of the State-Trait Anxiety Inventory (STAI) and Profile of Mood States (POMS) (Appendix B) inventories were administered (Spielberger, et al., 1970; McNair, et al., 1971). The tests were applied during appropriate periods of the World Cup Games so as to avoid interference by the emotional effects of impending or just completed competition. The POMS was

given again 18 months later to ascertain whether there might be differences in mood states under less stressful circumstances.

#### Statistical Analysis

Descriptive statistics were applied for the analysis of data. Means and standard deviations were computed. Pearson product-moment correlations were calculated to quantify relationships between physiological and psychological data. Further analyses were done in the form of analysis of variance in order to determine the effect of position and of starter/substitute role. Significant  $F$ -ratios were followed by a Duncan's multiple range test. In order to determine whether there were differences in POMS scores from World Cup testing to scores 18 months later a paired  $t$ -test was calculated. An alpha level of .05 was selected for all analyses.

## CHAPTER III

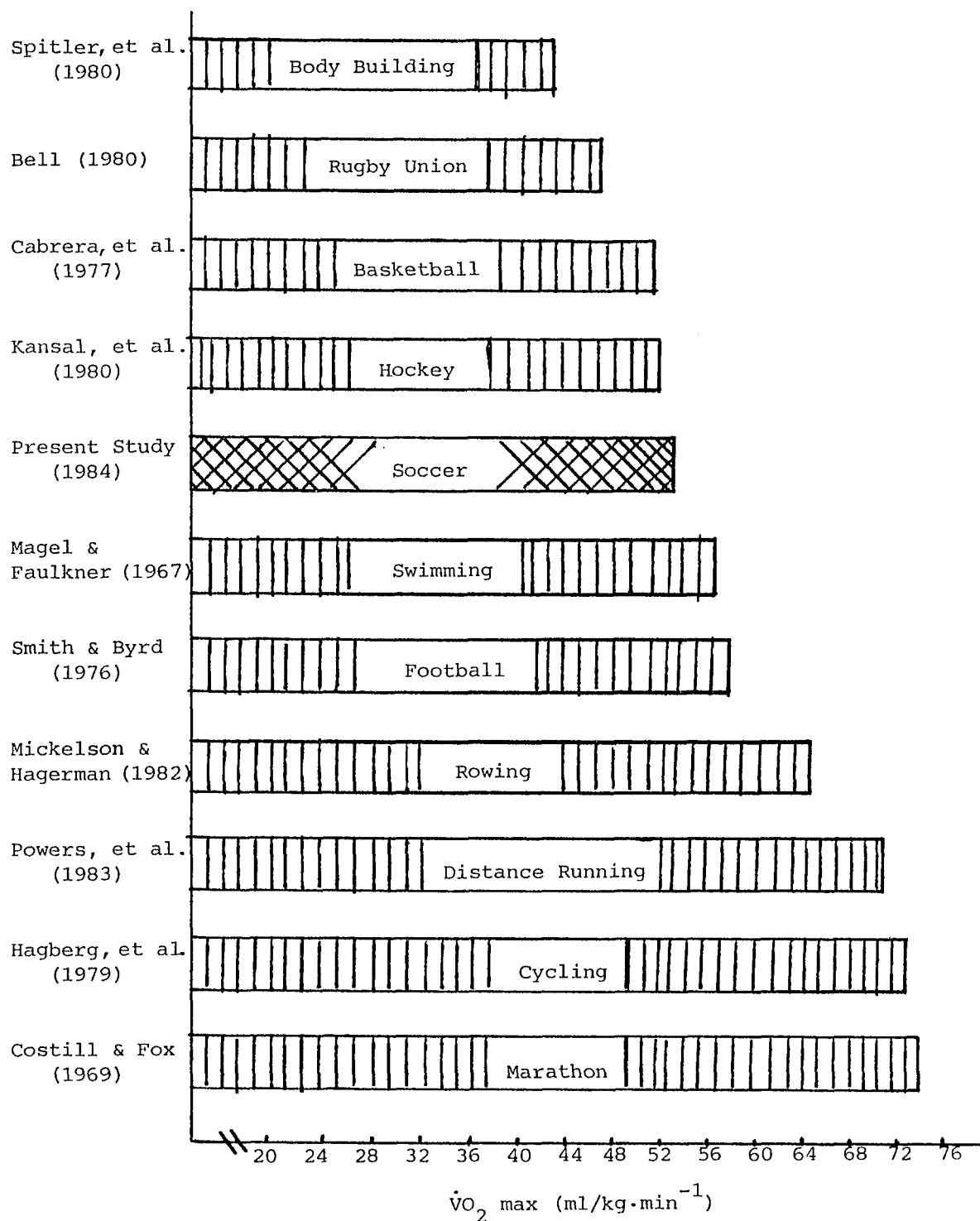
### RESULTS & DISCUSSIONS

#### V<sub>O2</sub> Max

While soccer is believed by many to be a sport that places heavy demands on the aerobic energy system, comparison of maximum oxygen consumption of soccer players with participants in other sports is not supportive of this concept. The mean maximal aerobic power of the Kuwaiti World Cup Soccer Team of 1982 was  $51.9 \text{ ml/kg}\cdot\text{min}^{-1}$  (Figure 1). American football players have been reported to have maximum oxygen consumptions of 56.5, 51.3, and  $50.1 \text{ ml/kg}\cdot\text{min}^{-1}$  (Smith & Byrd, 1976; Novak, et al., 1969; Wilmore & Haskell, 1972). Values for basketball players were 50.4, while those of marathon runners and middle-long distance runners were 74.1 and 78.7, respectively (Pollock, et al., 1975). Saltin and Astrand (1967) reported scores for groups of outstanding athletes to range from 57 to  $82 \text{ ml/kg}\cdot\text{min}^{-1}$ . Examination of Figure 1 illustrates clearly that the capacity of the Kuwaiti World Cup Soccer Team for aerobic metabolism is toward the center of the continuum for elite athletes.

There might be natural conjecture that the  $51.9 \text{ ml/kg}\cdot\text{min}^{-1}$  in the present study simply illustrates a lack of adequate aerobic fitness in the Kuwaiti Team, a possible explanation of their

Figure 1. Mean Relative Maximal Oxygen Consumption of Elite Athletes in Various Sports.

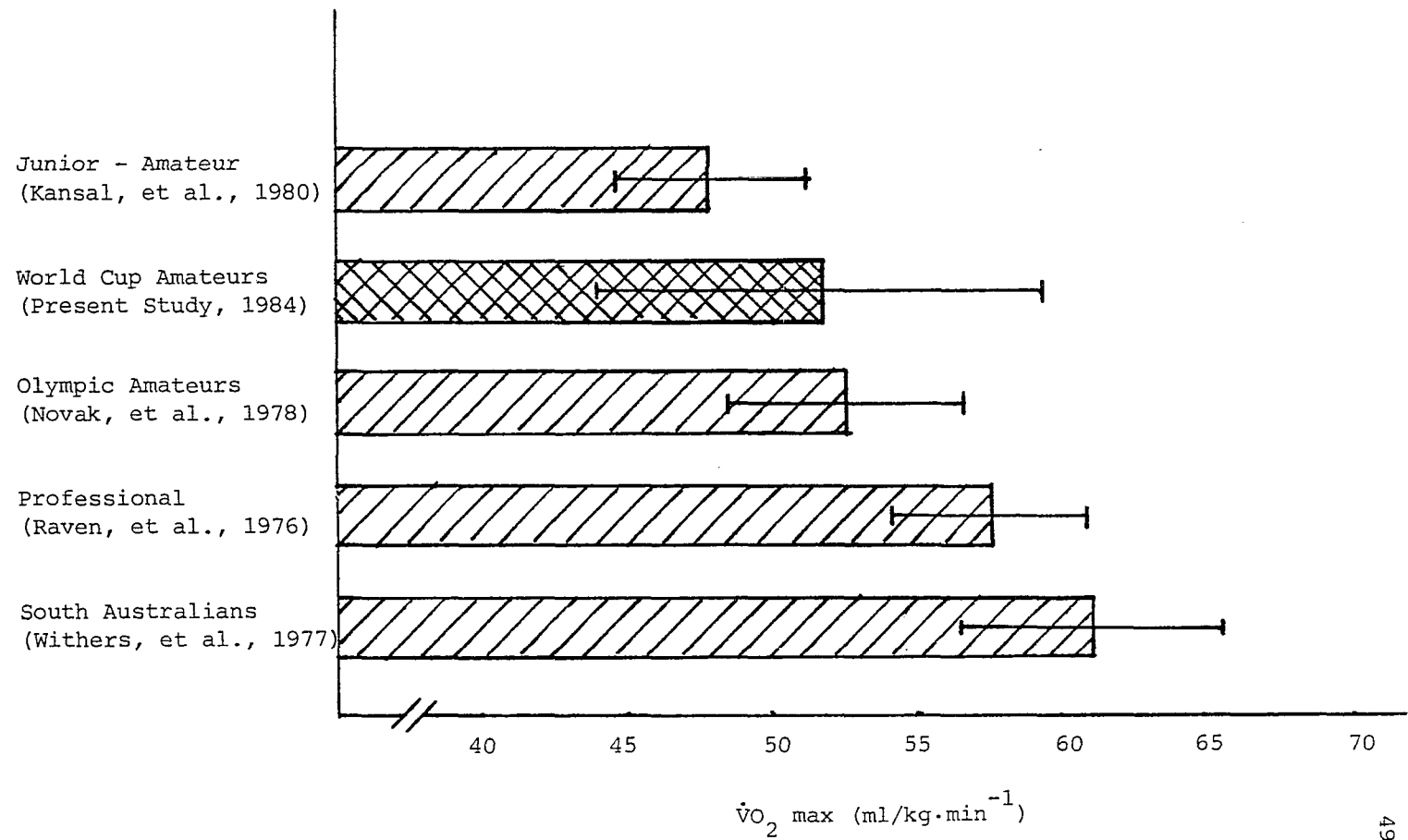




failure to fare exceptionally well in the World Cup Championships. It should be noted that the aerobic power of Moroccan Olympic soccer athletes was  $53.2 \text{ ml/kg} \cdot \text{min}^{-1}$  (Novak, et al., 1978), while that of 18 professional players in the North American Soccer League was 58.4 (Raven, et al., 1976) (Figure 2). In considering the somewhat higher level of the professionals, one must consider that both had used the treadmill in obtaining  $\dot{V}O_2$  max, while in the amateurs, the cycle ergometer was used. Treadmill protocols consistently yield higher  $\dot{V}O_2$  max values than on the cycle ergometer. Values of 5, 6, 8, 11, 10.2 to 11.2 and 17 per cent higher  $\dot{V}O_2$  max on the treadmill compared to the cycle ergometer have been obtained (Åstrand & Saltin, 1961; Hermansen, Ekblom, & Saltin, 1970; Glassford, Baycroft, Sedgwick, & McNab, 1965; Faulkner, Roberts, Elk, & Conway, 1971; McArdle, Katch, & Pechar, 1973; & Wicks, Sutton, Oldridge, & Jones, 1978). Hence, the approximately 10% higher  $\dot{V}O_2$  max value in the professionals may be accounted for by the difference in exercise testing mode. A possible explanation for this phenomenon is the larger muscle groups that are used in running on a treadmill than cycling the bicycle ergometer, and the more rapid local fatigue of the smaller muscle mass on the cycle ergometer that prevents the subject from reaching a higher  $\dot{V}O_2$  max.

While the present data can provide no support for attribution

Figure 2. Means and Standard Deviations for  $\dot{V}O_2$  max of Elite Soccer Players.



of aerobic power to selection or to training, Fardy (1969) reported a 14.6% increase in aerobic power of college players after five weeks of soccer training. Nonetheless, one might conclude that a higher capacity for aerobic metabolism is probably not a critical factor for success of elite amateur players, considering that the Kuwaiti team survived a demanding world-wide tournament, entering the World Cup finals as one of the top 24 teams.

In examination of aerobic capacity by position, no significant differences were found among offensive, defensive, and midfield players in the present study, with only the goalkeepers being unique (lower  $\dot{V}O_2$  max) (Table 1). This is in contrast to the findings of Raven, et al. (1976), who reported the highest values of  $\dot{V}O_2$  max for the offensive and defensive players, followed by the midfielders and lastly, the goalkeepers. The goalkeepers' activities and movements are very limited, whereas the midfielders travel the greatest distances. Reilly and Thomas (1976) monitored the positional role as a function of performance in the total distance covered in soccer match play throughout a complete soccer season. The total distance covered by the players per game was between 7069 and 10921 meters, with a mean of 8680 meters. They found that the midfield players covered significantly greater distances than the goalkeeper, offensive,

Table 1  
Comparison of Relative  $\dot{V}O_2$  max of Professional, Amateur,  
and Junior Amateur Soccer Players by Position

Subjects Soccer Players	Present Study (1984) Amateurs	Raven, et al. (1976) Professionals	Kansal, et al. (1980) Junior Amateur
Offensives	51.1 $\pm$ 5.0* (4)a	59.6 $\pm$ 2.7 (5)	50.0 $\pm$ 1.6
Midfielders	55.9 $\pm$ 4.4 (3)	56.1 $\pm$ 2.0 (2)	49.5 $\pm$ 2.7
Defensives	52.3 $\pm$ 5.8 (8)	59.3 $\pm$ 3.9 (9)	45.6 $\pm$ 4.0
Goalkeepers	48.0 $\pm$ 4.4 (3)	53.7 $\pm$ 1.4 (2)	44.4 $\pm$ 2.1
Total	51.9 $\pm$ 8.0 (18)	58.4 $\pm$ 3.5 (18)	48.3 $\pm$ 3.3

\*-Values are means  $\pm$  standard deviation.

a-Values between brackets shows number of subjects.

and the defensive players, suggesting a need for a higher aerobic fitness level for the midfield players. When the team was subdivided into the starters and the substitutes,  $t$ -test revealed that the starters were significantly older, had lower HR max, and had a higher relative  $\dot{V}O_2$  max. Whether this was a function of selection or training cannot be determined

In summary, aerobic capacity appears to be very important for athletes playing soccer at a high competitive level, especially for the outfield players. The required values are lower than those of world-class distance runners, but are significantly higher than those found in the normal sedentary population. Aerobic power is not critical for the goalkeepers, rather, greater muscular power is needed. It is felt that the Kuwait soccer team, except perhaps for the goalkeepers, in order to compete in World Cup games, should possess a higher potential for aerobic capacity than was demonstrated in this study.

#### Anaerobic Power

Anaerobic power of athletes from various sports and events has been extensively studied (Table 2). Athletes in general have higher anaerobic power than nonathletes and there is great disparity across sports. Soccer players in the present study were characterized by anaerobic power intermediate between the extremes of football players and marathoners. This finding suggests that

Table 2  
Anaerobic Power Comparison Among Various Sports and Events  
(Means + Standard Deviation)

Sport	N	Wt(kg)	VJ(cm)	Power (kg-m·sec <sup>-1</sup> )	Study
Football (College)	14	89.0±10.8	55.9±5.1	147.2±17.6	Beckenholdt, et al. (1983)
Basketball	8	81.3±6.1	53.0±0.6	133.9±11.4	Beckenholdt, et al. (1983)
Sprinters	5	70.5±7.3	-----	127.1±10.8	Thomson, et al. (1981)
Volleyball	8	85.5±4.5	67.0±11.5	126.8	Puhl, et al. (1982)
Wrestling	6	72.2±6.6	44.6±5.7	122.2±39.3	Beckenholdt, et al. (1983)
Soccer	13	68.5±7.1	55.0±0.6	119.6±18.5	Present Study (1984)
Middle & Long Distance Running	15	68.5±5.5 <sup>b</sup>	-----	109.6±12.2 <sup>b</sup>	Taunton, et al. (1981)
Nonathletes	55	73.3±10.6	-----	107.8±-----	Nelson & Dorociak (1981)
Marathon	5	64.3±6.0	-----	96.7±12.1	Thomson, et al. (1981)

b = ± S.E.

soccer is neither a highly demanding anaerobic activity nor is it purely aerobic, but rather combines both energy requirements to a moderately high degree.

Anaerobic power is probably more important to top level athletes than to those at lower levels for success in soccer performance. The world class athletes of the present study possessed higher anaerobic power than U.S. college players (Beckenholdt & Mayhew, 1983), Italian young amateurs (Caru, et al., 1970), or India's young National soccer players (Verma, et al., 1979) (Figure 3). With higher levels of soccer championships and tournament play, aggressiveness, speed, and power become more important. This explains the superiority of the Kuwaiti World Cup athletes in anaerobic power output, compared to the Italian youngsters who compete at the junior level. At this time, Europeans have the highest soccer standards in the world. The final four teams in the 1982 soccer World Cup were from Europe (Italy, Germany, Poland, and France). Thus it is not surprising that the Italian amateur players had higher anaerobic power than the Indian Junior National representatives or the U.S. college players. The European soccer standards at all levels are higher than the corresponding Asian or North American levels.

There appears to be a positional role effect on the anaerobic power (Figure 4). Caru, et al. (1970) and Verma, et al. (1979)

Figure 3. Comparison of Anaerobic Power of Soccer Athletes  
in Different Levels

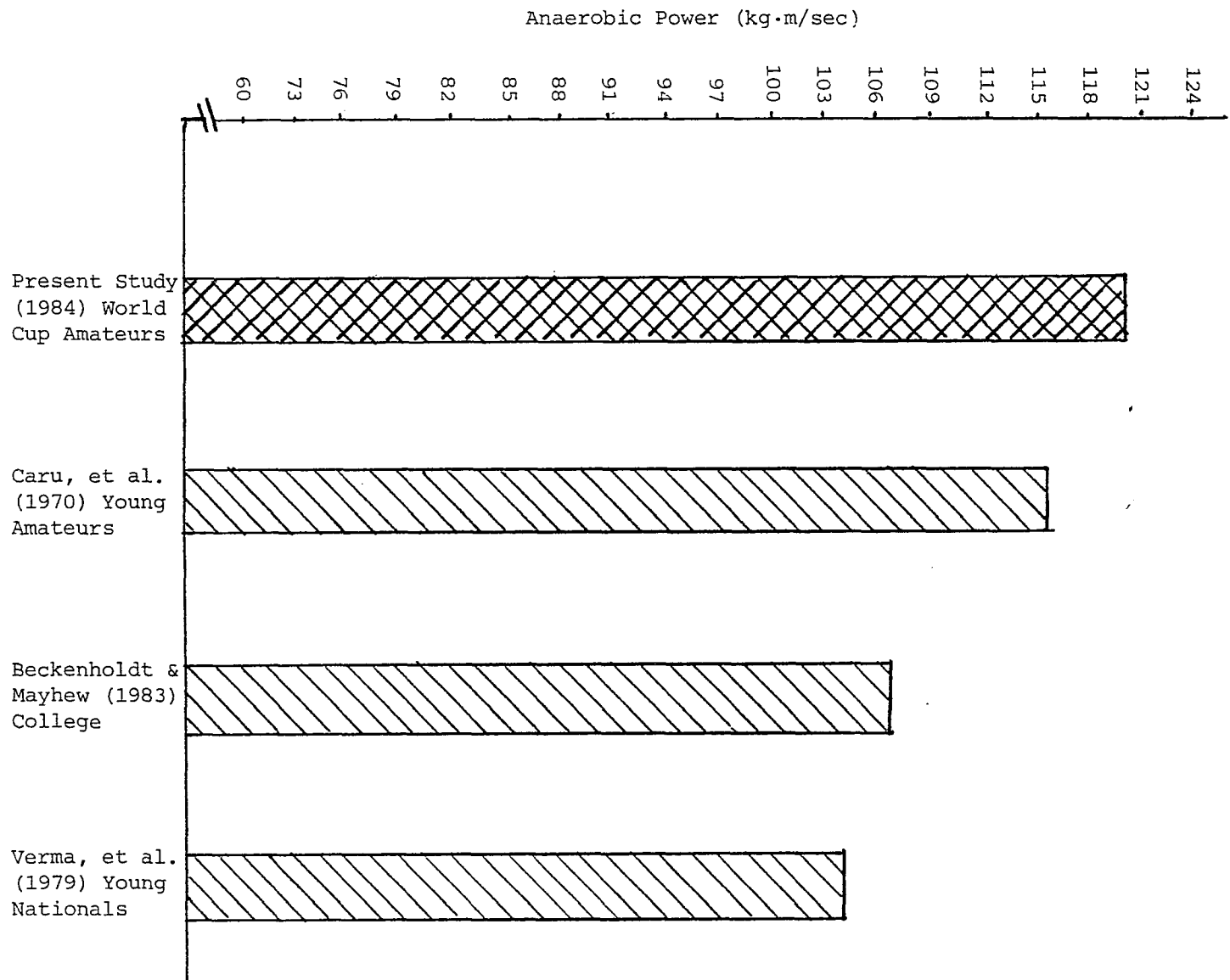
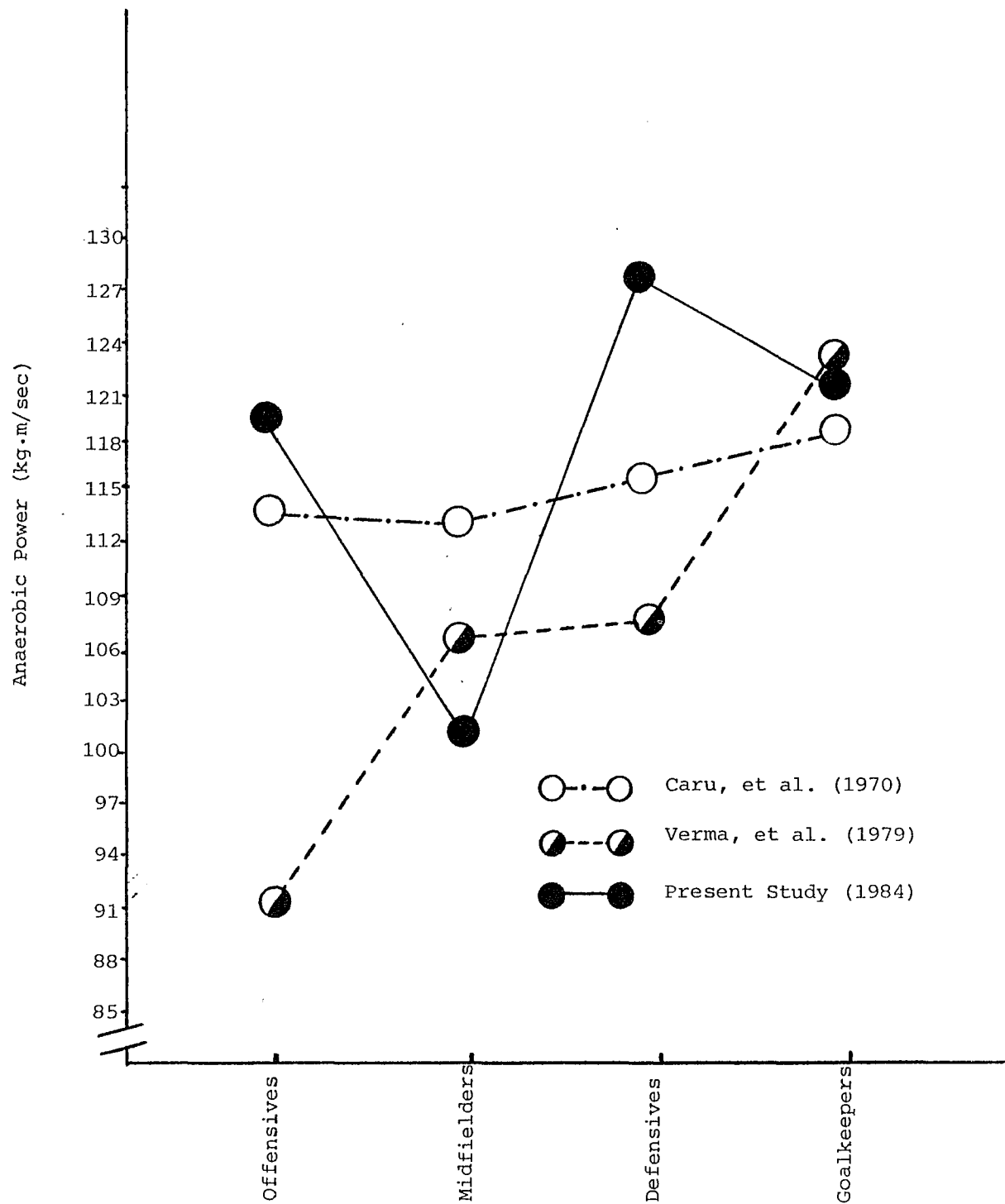




Figure 4. Comparison of Anaerobic Power of Soccer  
Players According to Position.



found goalkeepers to have the highest anaerobic power, while the defensives ranked second. These positions were reversed in the present project, but combining data of the three studies clearly indicates a dichotomy by position. The goalkeepers and defensives ( $\bar{x}$  = 120 and 117 kg.m/sec, respectively) lie in one group, with the midfielders and offensives ( $\bar{x}$  = 107 and 108) exhibiting lower values. Data across the three studies were fairly consistent, except for the much lower anaerobic power of the Indian offensives (Verma, et al., 1979).

The high anaerobic power of the goalkeepers, defensives and the offensive players in the present study reflect the role of these positions and their requirements in high standard play. The Kuwaiti midfielders' strategy was to run up and down the entire soccer field in order to support both the offensive and the defensive players in their execution of tactics and strategies. Thus, the demand for aerobic power for the midfielders was much more pronounced than was the need for anaerobic power. The short sprints and violent muscular activity was more pronounced in the offensive, defensive, and the goalkeepers, not requiring the more consistent prolonged work characteristic of the Kuwaiti midfielders. It is of interest to consider the degree to which positional demands of aerobic/anaerobic capacities predetermine the potential for success by individuals. How much are players'

characteristics a function of selection and to what degree are capacities molded by training, competition and coaches' strategy? The answers are beyond the scope of the present data, but are nonetheless important.

A motion analysis of work-rate in professional soccer match-play (Reilly & Thomas, 1976) revealed that, on the average, a soccer player jogged 3187 meters, walked 2150 meters, and sprinted 974 meters per game. In support of the data in Figure 4, they also revealed positional role differences, with the midfielders covering significantly greater distances than the offensives, defensives, or goalkeepers. This suggests that a more prolonged, lower work-rate is a requirement for the midfield player. Conversely, the offensives and the defensive players were more involved in sprint activity. Speed endurance training was advised for those athletes. The goalkeepers need great anaerobic power for successful jumping and for short sprints. Reilly and Thomas (1976) noted relatively short distances covered by the goalkeeper in quick movements with and without possession of the ball, supporting the need for anaerobic rather than aerobic power for this position.

Comparison among the starters (the eleven players who usually start the match) and the substitutes (the rest of the team) revealed no significant differences in anaerobic power between the

two groups (Table 3). The starters were significantly older; considering that anaerobic power decreases as age increases (Margarita, et al., 1966), one might point to this as a factor related to lack of superiority of the starters. However, the fact that concentration in both training and matches is always focussed on the starters, it might be expected that this would more than offset any age-related deficiency. Another confounding factor is that the heavy pre-World Cup schedule might have had a telling effect on the starters, resulting in some residual fatigue and loss of anaerobic power (Tschiene, 1972). Finally, considering that even substitutes on a World Cup team would be expected to be elite athletes, well suited to the demands of soccer, it is perhaps not surprising that they were not different from the starters in anaerobic power.

In conclusion, differences in anaerobic power by position played as well as the ranking of soccer midway among other sports were reflective of the metabolic demands of play. While poor anaerobic power in untrained subjects is often accompanied by low levels of aerobic capacity, simultaneous development of extremely high anaerobic and aerobic capacities might not be possible. These appear to be mutually exclusive, with athletes in only a few sports exhibiting simultaneous moderately high levels in both. Factors contributing to this limitation are genetically imposed

Table 3  
 Anaerobic Power of the Kuwaiti World Cup Soccer Team -  
 Differences Between the Starters and the Substitutes

Variables	Starters	Substitutes	Total
Weight (kg)	65.8 $\pm$ 7.1*	70.7 $\pm$ 6.5	68.5 $\pm$ 7.1
Vertical Jump (cm)	53.7 $\pm$ 6.9	55.6 $\pm$ 5.9	55.0 $\pm$ 6.0
Anaerobic Power (kg.m/sec)	111.95 $\pm$ 10.9	124.72. $\pm$ 21.2	119.61 $\pm$ 18.5

\* Values are Means  $\pm$  Standard Deviation

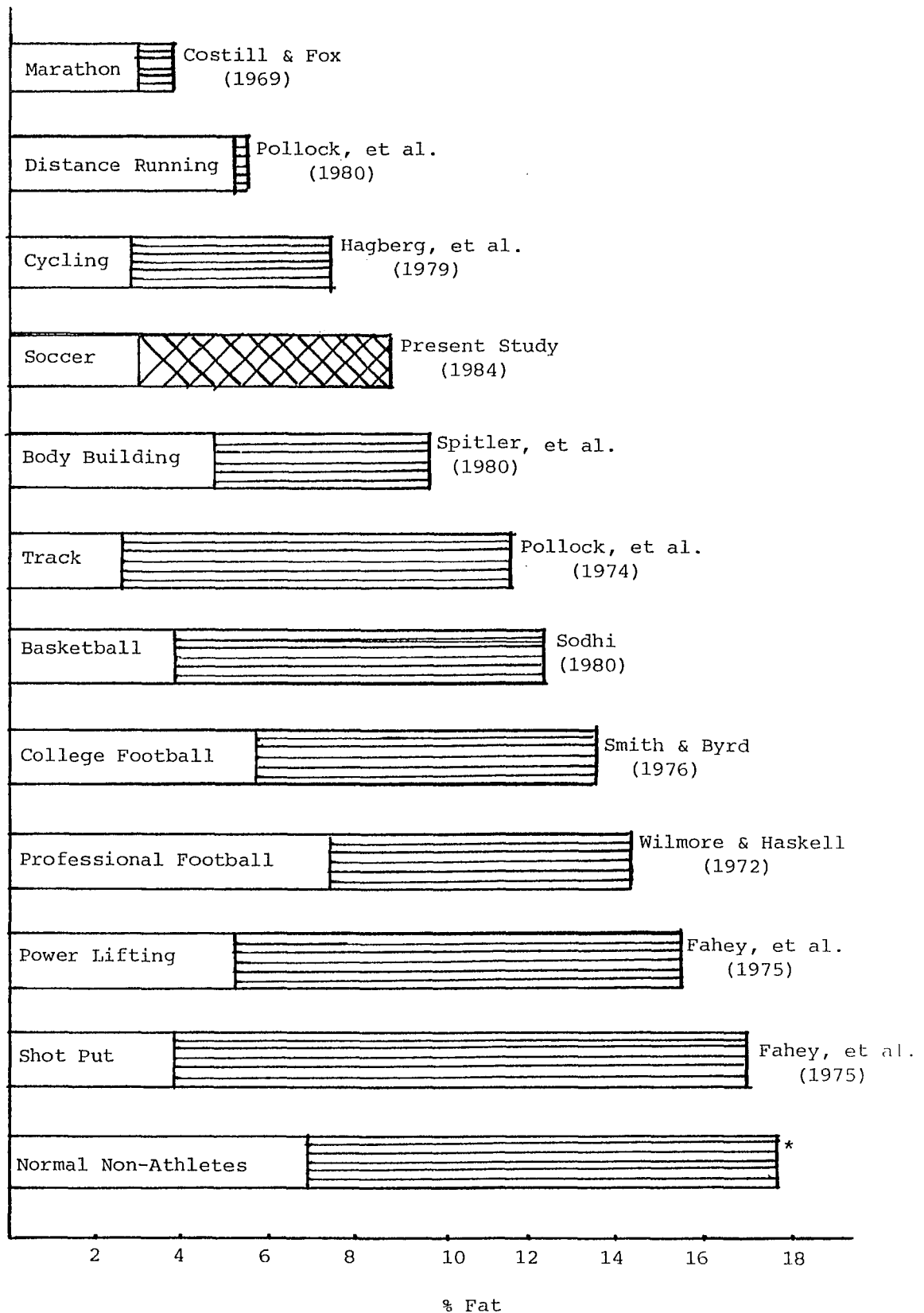
skeletal muscle fiber type as well as the demands of training specific to a sport. Soccer is clearly a sport that rewards moderation in fiber type distribution while demanding simultaneous optimal development of both anaerobic and aerobic capacities.

#### Body Composition

Athletes generally have a lower percentage of fat than non-athletes (Figure 5), but are higher in lean body mass. The average per cent fat for normal adult male ranges between 15 and 17, while that of females is about 25 (Fox & Mathews, 1981). Wilmore and Behnke (1969) found normal college males to possess about 14.6 per cent fat, whereas Jackson and Pollock (1978) reported 17.7 per cent fat for 308 normal males ranging between 18 and 61 years of age. Fat determination has become popular with both athletes and coaches because: (a) fat cells and adipose tissue per se are not biochemically active in generating ATP (adenosine triphosphate), an essential substance for producing necessary energy in the working muscles; (b) excess fat contributes weight but not metabolic assistance for movement, and; (c) excess fat weight hinders agility, power, and endurance.

Investigators have categorized the per cent fat of athletes from different sports and events (Table 4). Soccer players of world class (present study), professional (Raven, et al., 1976), and university level (Kansal et al., 1980) have 8.0 to 9.9 per

Figure 5. Mean Per Cent Fat of Athletes in Various Sports.



\* Jackson & Pollock (1978)

Table 4  
Per Cent Fat of Athletes of Various Sports

% Fat	Event or Sport	Reference
<7.9	Elite marathon runners, distance runners, cyclists, Olympic swimmers, rowers, soccer	Costill & Fox, 1969; Costill, et al., 1970; Pollock, et al., 1980; Hagberg, et al., 1979; Novak, et al., 1978.
8.0-9.9	Soccer, body builders, lacrosse, wrestlers, water polo	Spitler, et al, 1980; Shaver, 1980; Novak, et al., 1978; Fahey, et al., 1975; Raven, et al., 1976; Kansal et al., 1980; and present study, 1984.
10.0-11.9	Track athletes	Pollock, et al., 1974.
12.0-13.9	College football, basketball, decathlon, rugby, judo, college athletes, runners & walkers, Olympic weight lifters, volleyball	Smith & Byrd, 1976, Sodhi, 1980; Faris, et al., 1980; Maud, 1983; Farmosi, 1980; Forsyth & Sinning, 1973; Withers, et al., 1977; Fahey, et al., 1975. Conlee, McGown, Fisher, Dalsky, & Robinson, 1982.
14.0-15.9	Professional soccer, power lifter, professional football rugby, normal college	Withers, et al., 1977; Fahey, et al., 1975; Wilmore & Haskell, 1972; Bell, 1980; Wilmore & Behnke, 1969; Wilmore, 1969.
>16.0	College football, normal adult, basketball, hockey, discus throw, shot put	Burke, et al., 1980; Jackson & Pollock, 1978; Withers, et al., 1977; Fahey, et al., 1975.



cent fat. U.S. National level body builders, and wrestlers (Fahey, et al., 1975, and Spitler, Diaz, Horvath, & Wright, 1980), lacrosse (Shaver, 1980), and Olympic water polo (Novak, et al., 1978) athletes fall in the same category. Athletes involved in events more demanding of endurance were leaner (<7.9%). This group included elite distance and marathon runners, cyclists, Olympic swimmers, rowers, and another group of soccer players. Other sports with differing requirements in training and competition are apparently less demanding in terms of leanness (Table 4).

The percentage of fat for soccer players in the present study was 8.9, markedly lower than that of normal non-athlete male subjects (Wilmore & Behnke, 1969; Jackson & Pollock, 1978). At the Olympic games of 1968 in Mexico, 12 to 20 per cent fat was reported for athletes in various sports by DiPrampiero, Pinera Limas, and Sassi (1970). They found no significant difference among the different events except for rifle shooters, who were found to be significantly more fat than other athletes and were also considered to be sedentary. Fahey, et al. (1975) compared fat of elite weight trained athletes in the shot put, the discus throw, body building, power lifting, and weight lifting. The overall per cent fat was 13.8. This mean was higher than that of the world class soccer players of the present study (8.9%). The

highest fat values were found in the shot-putters and discus throwers (16.5 and 16.4%), whereas the lowest values were among wrestlers, body builders, and Olympic weight lifters, with 9.8, 8.4, and 12.2 per cent, respectively. It is not clear whether the difference in per cent fat can be attributed more to the demand of the sport or to the level and standard of the competition. It is generally believed that success in competition in almost all sports requires a low relative body fat (Wilmore, 1983). Athletes who utilized weight and power in their sports generally had more per cent fat and higher lean body mass. Less fat percentage is characteristic of smaller athletes, particularly of those who need great speed and/or agility or who compete in body weight classifications. For example, wrestlers and weight lifters require a lower fat to lean weight ratio because they compete in weight divisions, soccer players must be fast and agile, and the judgement of body builders depends on their muscular definition which is hindered by a high per cent fat (Fahey, et al., 1975).

Shaver (1980) found soccer midfielders to be slightly taller, lighter and with less fat than the offensive and the defensive players. This finding was comparable with data on defensive backs in American college football players (Smith & Byrd, 1976) (Table 5). Lacrosse midfielders are permitted to go up and down the entire length of the playing field, somewhat similar to the play

Table 5  
Body Composition Comparison Between Soccer, Lacrosse,  
and Football Players in Various Positions

Study	Position	N	Ht	Wt	%Fat	LBW
Present (Soccer) (1984) $\bar{x}$ Age (Yrs) =24.7 $\pm$ 3.5	OF	5	174.7 $\pm$ 6.9	72.0 $\pm$ 6.6	9.2 $\pm$ 3.0	65.3 $\pm$ 6.0
	MD	4	168.0 $\pm$ 4.2	63.0 $\pm$ 9.8	6.2 $\pm$ 0.5	59.2 $\pm$ 9.5
	DF	8	172.6 $\pm$ 5.5	67.3 $\pm$ 4.7	8.8 $\pm$ 1.2	61.3 $\pm$ 3.8
	GK	2	170.0 $\pm$ 2.8	70.0 $\pm$ 1.4	13.9 $\pm$ 0.2	60.3 $\pm$ 1.1
	Total	19	172.1 $\pm$ 5.7	67.9 $\pm$ 6.7	8.9 $\pm$ 2.7	61.8 $\pm$ 5.8
Shaver (Lacrosse) (1980) $\bar{x}$ Age (Yrs) =20.3	OF	10	182.2	80.2	8.2	72.4
	MD	12	187.8	76.3	7.0	68.7
	DF	8	184.5	81.4	12.4	67.0
	Total	30	184.8	79.5	9.2	69.0
Smith & Byrd (Football) (1976) $\bar{x}$ Age (Yrs) =19.3 $\pm$ 1.7	OB	15	181.5 $\pm$ 10.2	83.1 $\pm$ 3.3	13.8 $\pm$ 5.3	71.6
	DB	4	183.7 $\pm$ 2.9	80.4 $\pm$ 4.3	9.6 $\pm$ 3.2	72.7
	OL	11	189.2 $\pm$ 4.3	97.9 $\pm$ 8.1	14.6 $\pm$ 2.9	83.5
	DL	7	188.8 $\pm$ 2.6	99.9 $\pm$ 11.6	14.3 $\pm$ 3.3	85.6
	Total	27	186.8 $\pm$ 6.0	93.1 $\pm$ 11.2	13.7 $\pm$ 3.8	80.3

OF=offensives; MD=midfielders; DF=defensives; GK=goalkeepers;  
OB=offensive backs; DB=defensive backs; OL=offensive lineman;  
DL=defensive lineman and linebackers

of mid-field soccer players (Reilly & Thomas, 1976) and the defensive backs in American football whose play is characterized by quick, agile movements coupled with considerable amount of running (Smith & Byrd, 1976). The positional demands of different sports are obvious.

Positional groupings of the present population revealed a significantly higher per cent fat of goalkeepers compared to offensives, defensives, and midfielders. This was in agreement with the findings of Raven, et al. (1976) and Bell and Rhodes (1975). Mid-field players in the present study showed a significant lower amount of fat tissue than the offensive and defensive players, whereas Raven, et al. (1976) reported the defensives to have the lowest per cent fat (Table 6). The physical demands and the positional roles in soccer require that the mid-field players be in relatively constant movement up and down the length of the soccer field, usually covering the greatest distance (Reilly & Thomas, 1976). This sort of significant difference between players of different positions could be expected in any sport in which there is clear differentiation in demands of play.

The 8.9% fat of the Kuwaiti soccer team was slightly higher than the value obtained by Novak, et al. (1978) on the Moroccan Olympic soccer team (6.2). Significantly higher fat values were

Table 6

## Per Cent Fat Differences Among Positional Groupings of Soccer Players

I. Raven, et al. (1976) - Professional Soccer - Mean Age (Yrs) = 25.6±1.0					
	N	Ht(cm)	Wt(kg)	% Fat	LBWt(kg)
OF	5	176.3±2.9	74.5±5.5	10.7±0.9	66.7±4.5
MD	2	175.0±2.9	77.3±3.6	10.6±2.3	69.1±4.9
DF	9	176.0±1.9	73.6±1.8	8.1±1.2	67.5±1.7
GK	2	178.0±2.2	86.4±4.5	13.3±0.0	75.1±3.8
Total	18	176.3±1.2	75.7±1.9	9.6±0.7	68.3±1.5
II. Bell & Rhodes (1975) - First Team College					
OF	16	-----	-----	14.7	-----
MD	18	-----	-----	14.6	-----
DF	20	-----	-----	14.7	-----
GK	7	-----	-----	16.9	-----
Total	61	-----	-----	14.7	-----
III. Present Study (1984) - World Class Soccer - Mean Age (Yrs) = 24.7±3.5					
OF	5	174.7±6.9	72.0±6.6	9.2±3.0	65.3±6.0
MD	4	168.0±4.2	63.0±9.8	6.2±0.5	59.2±9.5
DF	8	172.6±5.5	67.3±4.7	8.8±1.2	61.3±3.8
GK	2	170.0±2.8	70.0±1.4	13.9±0.2	60.3±1.1
Total	19	172.1±5.7	67.9±6.7	8.9±2.7	61.8±5.8

reported by Withers, et al. (1977) on the South Australians (15.7%) and Bell and Rhodes (1975), who studied college players (15.2%) Professional soccer players (Raven, et al., 1976) and the Indian university soccer players (Kansal, et al, 1980) revealed comparable values of fat percentage to the present study data (9.6% and 9.8%, respectively) (Table 7). There is an apparent relationship between level of performance and per cent fat values. This might be attributed to the greater volumes of work and higher intensities of training programs characteristic of higher levels of play. Aspiration, motivation, and selection might also be factors, as well as differences in methodological procedures involved.

The starters in the present study were significantly older and had significantly lower fat percentages than the substitutes (Table 8). The substitutes were slightly heavier and taller. The greater experience of the starters is understandable; their greater involvement in training and "friendly" matches as well as in more demanding and important competitions could also explain their lower per cent fat by higher metabolic demands.

#### Somatotype

Somatotypes of athletes provide information related to the structural requirements for success in the specific sport as well as measures of the characteristic differences between sports

Table 7  
Means and Standard Deviations of Body Composition of Soccer Players

	Age(yrs)	Ht(cm)	Wt(kg)	%Fat	LBM(kg)
Bell & Rhodes (1975) College	-----	-----	-----	15.2	-----
Raven, et al. (1976) Professional	25.6±1.0	176.3±1.2	75.7±1.9	9.6±0.7	68.3±1.5
Withers, et al. (1977) Australian	24.4±4.5	178.1±8.1	75.2±4.9	15.7±2.3	-----
Novak, et al. (1978) Olympic Soccer	24.8±1.9	174.1±8.1	71.8±6.6	6.2±1.9	67.3±2.6
Kansal, et al. (1980) University Level	-----	169.2±4.8	55.9±5.1	9.8±2.4	-----
Present Study (1984) World Class	24.7±3.5	172.1±5.7	67.9±6.7	8.9±2.7	61.8±5.8

Table 8  
 Body Composition of World Class Soccer Players -  
 Comparison Among the Starters and the Substitutes

Subjects	N	Age(yrs)	Ht(cm)	Wt(kg)	%Fat	FFW(kg)
All	19	24.7 $\pm$ 3.5	172.1 $\pm$ 5.7	67.9 $\pm$ 6.7	8.9 $\pm$ 2.7	61.8 $\pm$ 5.8
Starters	9	26.9 $\pm$ 3.2*	170.2 $\pm$ 5.0	65.8 $\pm$ 7.1	7.5 $\pm$ 1.6*	60.8 $\pm$ 6.9
Substitutes	10	22.6 $\pm$ 2.4	173.9 $\pm$ 6.1	69.8 $\pm$ 6.1	10.1 $\pm$ 2.9	62.7 $\pm$ 5.0

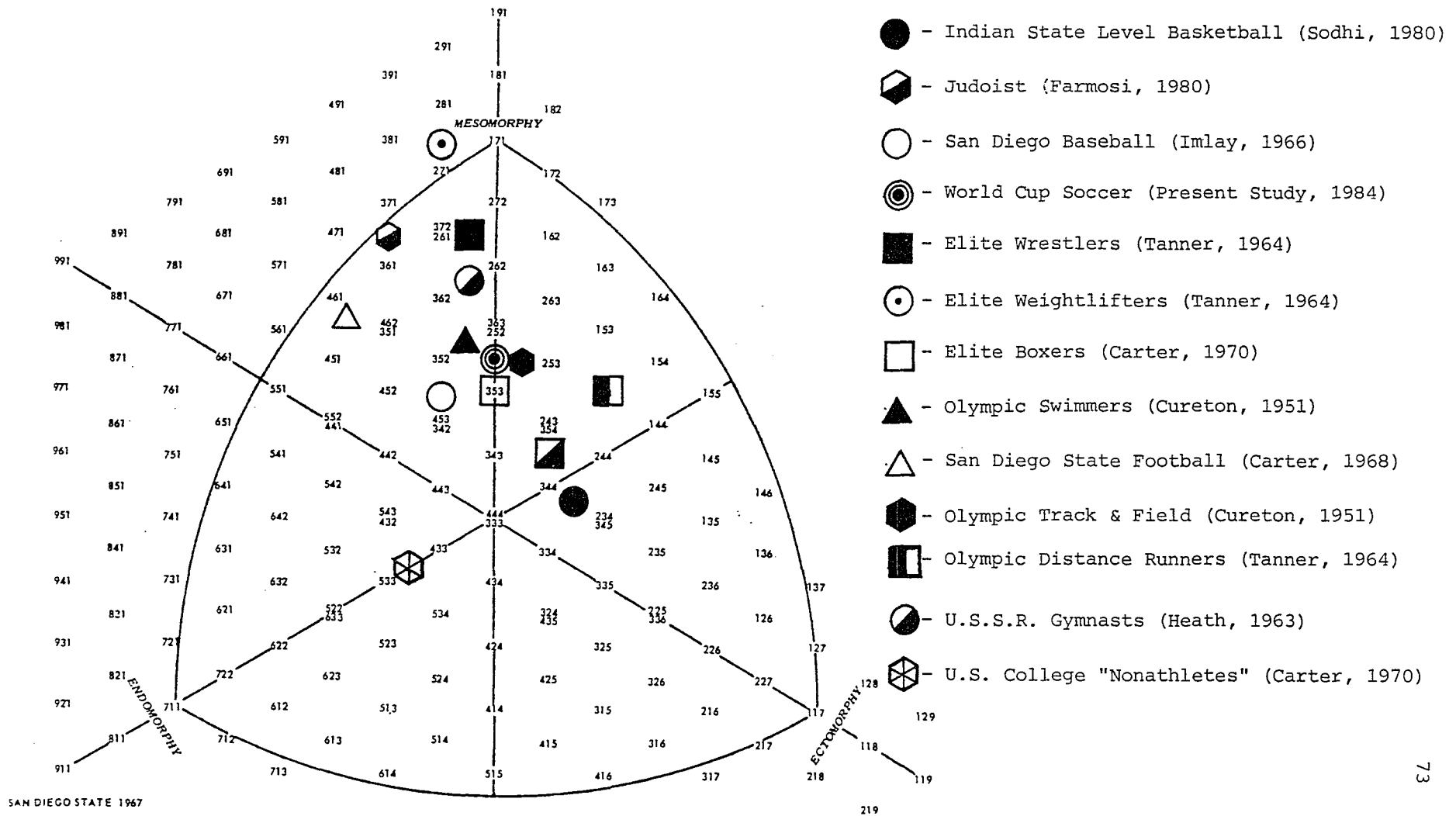
\*Significant at 0.05 level.



(Carter 1970). Hirata (1966) in his study on the physique of Tokyo Olympic champions, presented evidence on the importance of height, weight and physique on performance. He suggested that countries with people whose general physique was limited to the characteristics of champions in certain events should concentrate on those events.

Somatotype values for different sports are shown in Figure 6. Examination of those values revealed that the lowest values in endomorphy were shown in the Olympic distance runners (Tanner, 1964), whereas, the San Diego State football players scored the highest value (Carter, 1968). The Kuwaiti soccer players had endomorphic values similar to those of British Empire Games wrestlers and weightlifters (Tanner, 1964). Muscularity or mesomorphy was the primary characteristic of the weightlifters and the judoists (Tanner, 1964; Farmozl, 1980). The Kuwaiti soccer players, the U.S.S.R. basketball athletes, the Olympic distance runners, and the Indian State level basketball players had the lowest values in mesomorphy. The U.S.S.R. basketball players and the Indian State level basketball players had the highest score in ectomorphy and the British Empire Games weightlifters revealed the lowest. The mean overall somatotypes showed that the Kuwaiti soccer players, the Olympic swimmers and track & field athletes (Cureton, 1951), and the British Empire Games Boxers (Carter,

Figure 6. Means of Somatotype for Various Sports.



1970) were about the same in body physique and shape (Figure 6).

Champion athletes were characterized by Carter (1970) to be above a normal college population in muscularity. Somatotypes of athletes from various kinds of sports and a college population were compared. The college students were characterized as being more endomorphic and less mesomorphic than the champion athletes, and they followed the basketball players in ectomorphy (Figure 6). The somatotypes of the present study indicated that the Kuwaiti team was composed of mesomorphic athletes with equal amount of endomorphy and ectomorphy (2.1-4.5-2.1) (Figure 7). This finding was in agreement with Hiratas' (1966) study on Tokyo Olympic soccer champions. He characterized the physique of champion soccer players as rather small and a little stout.

Elite track and field players, boxers, and baseball players have physiques similar to those of soccer athletes (Figure 6). This suggests that the physical demands for the above mentioned sports appear to be similar. Endurance, strength, power, and agility may be important for success in all of these events.

There were no significant differences between the starters and substitutes in somatotype (Figure 8 and Table 9). Comparisons by positional groupings also revealed a significant difference in endomorphy between the goalkeepers and the rest of the athletes (Figure 9 and Table 9). The goalkeepers were significantly more

Figure 7. Somatochart of the Kuwaiti World Cup Soccer Team.

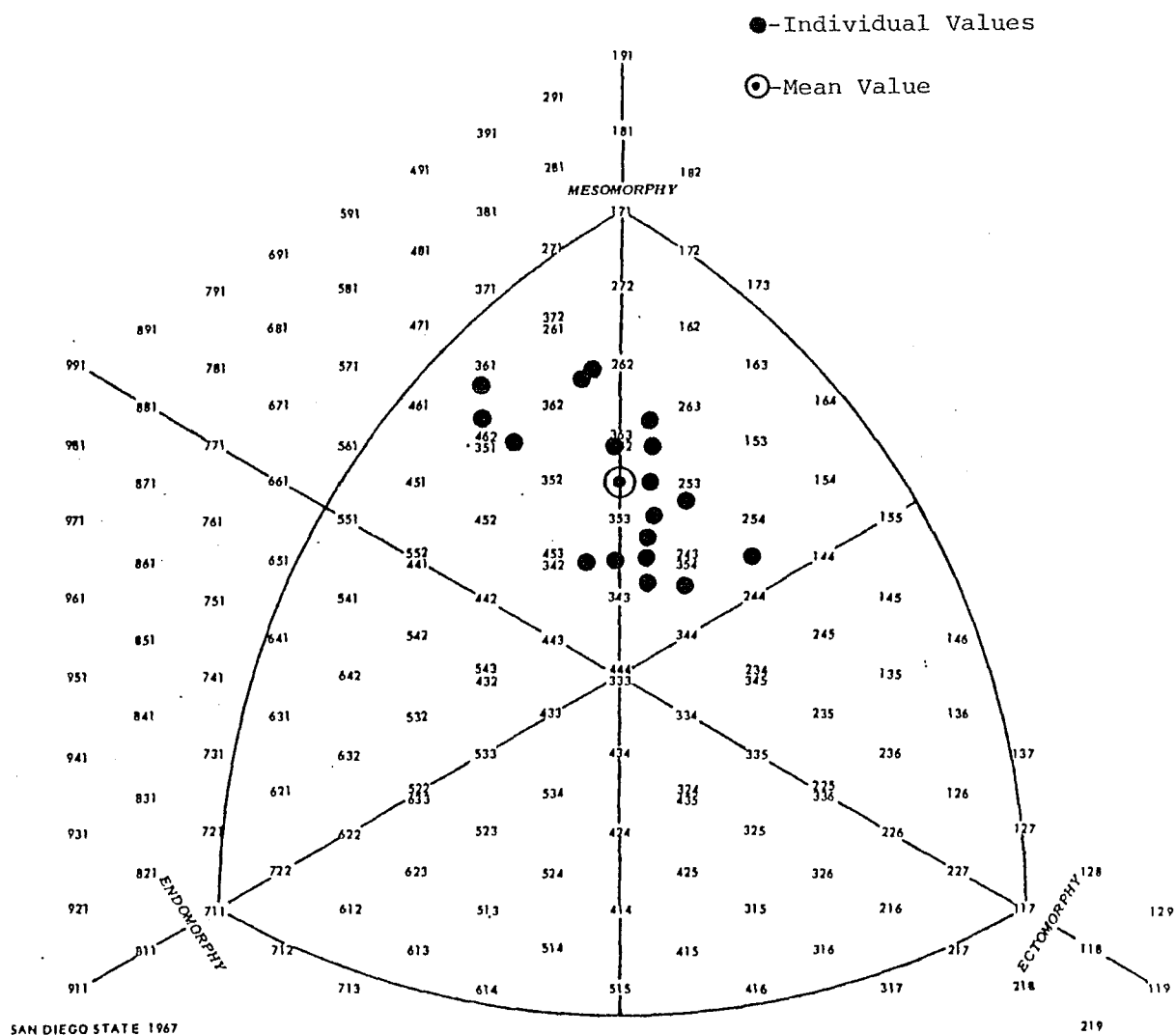


Figure 8. Comparison of the Somatotypes of the  
Starters and the Substitutes of the Kuwaiti  
World Cup Soccer Team.

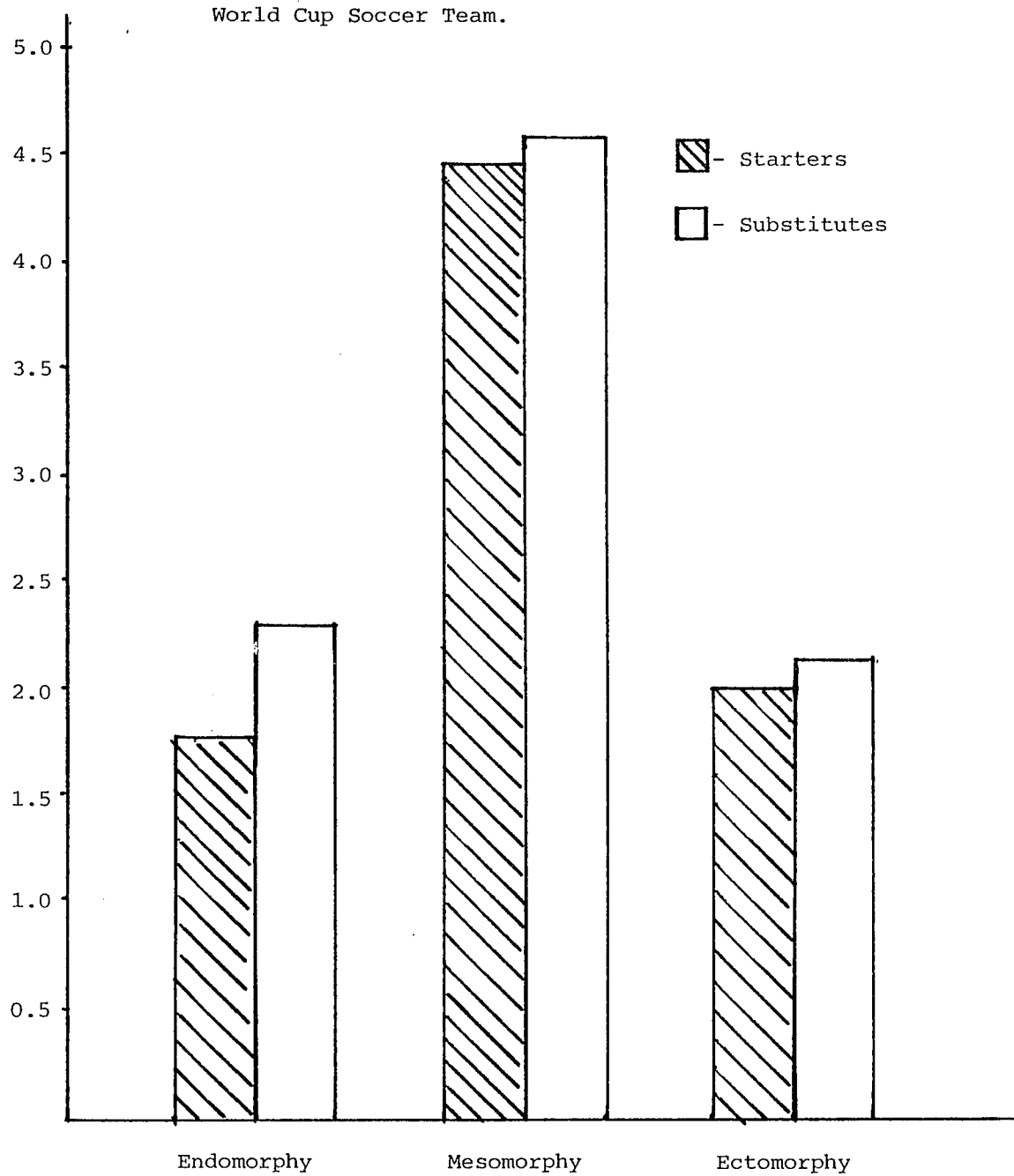


Table 9  
Somatotypes of Soccer Athletes - Starters, Substitutes,  
and Positional Group Differences<sup>a</sup>

Subjects	All	Starters	Substitutes	Defensives	Midfielders	Offensives	Goalkeepers
Somatotype	N=18	N=8	N=10	N=7	N=4	N=5	N=2
Endomorphy	2.06±0.51	1.75±0.27	2.30±0.54	2.00±0.29	1.63±0.25	2.10±0.55	3.00±0.00*
BT1	(1.5-3.0)	(1.5-2.0)	(1.5-3.0)	(1.5-2.5)	(1.5-2.0)	(1.5-3.0)	(3.0-3.0)
Mesomorphy	4.50±0.69	4.44±0.67	4.55±0.74	4.19±0.70	4.63±0.43	4.45±0.65	5.50±0.35*
BT2	(3.5-5.8)	(3.5-5.0)	(3.75-5.75)	(3.5-5.0)	(4.0-5.0)	(3.75-5.25)	(5.25-5.75)
Ectomorphy	2.08±0.75	2.00±0.71	2.15±0.82	2.29±0.39	2.38±1.11	1.90±0.82	1.25±0.35
BT3	(1.0-3.5)	(1.0-3.0)	(1.0-3.5)	(2.0-3.0)	(1.0-3.5)	(1.0-2.5)	(1.0-1.5)

a-Values are means ± standard deviation, the range are bracketed.

\*-Significant at 0.05 level.

muscular than the offensive and the defensive players. The somatochart showed that the goalkeepers were rated as being endo-mesomorphic, the midfielders and the defensive players as ecto-mesomorph, and the offensive players as balanced mesomorph.

These classifications are consistent with previously discussed aerobic/anaerobic demands, body composition differences, and characteristics of play by position. Somatotypes of the Kuwaiti World Cup soccer team were suitable, both by consideration of measures taken previously on soccer players and other athletes, and by analysis of the demands of the sport.

#### Profile of Mood States and State-trait Anxiety Inventory

Means and standard deviations for Profile of Mood States (POMS) and State-trait Anxiety Inventory (STAI) are shown in Table 10. Analysis of data revealed that the World Class soccer athletes were significantly less depressed, tense, and confused than the college norms, but significantly higher on vigor and anger factors. This finding was in agreement with previous research on other types of athletes participating in running, jumping, sprinting and cycling (Hagberg, et al., 1979; Morgan & Pollock, 1977; & Thomas, et al., 1983) except that the anger factor of POMS in the present study was contradictory to results from earlier studies (Figure 10). The finding led the researcher to seek possible explanations. One explanation for the high anger

Figure 9. Somatotypes of the Kuwaiti World Cup Soccer Players  
by Position Played.

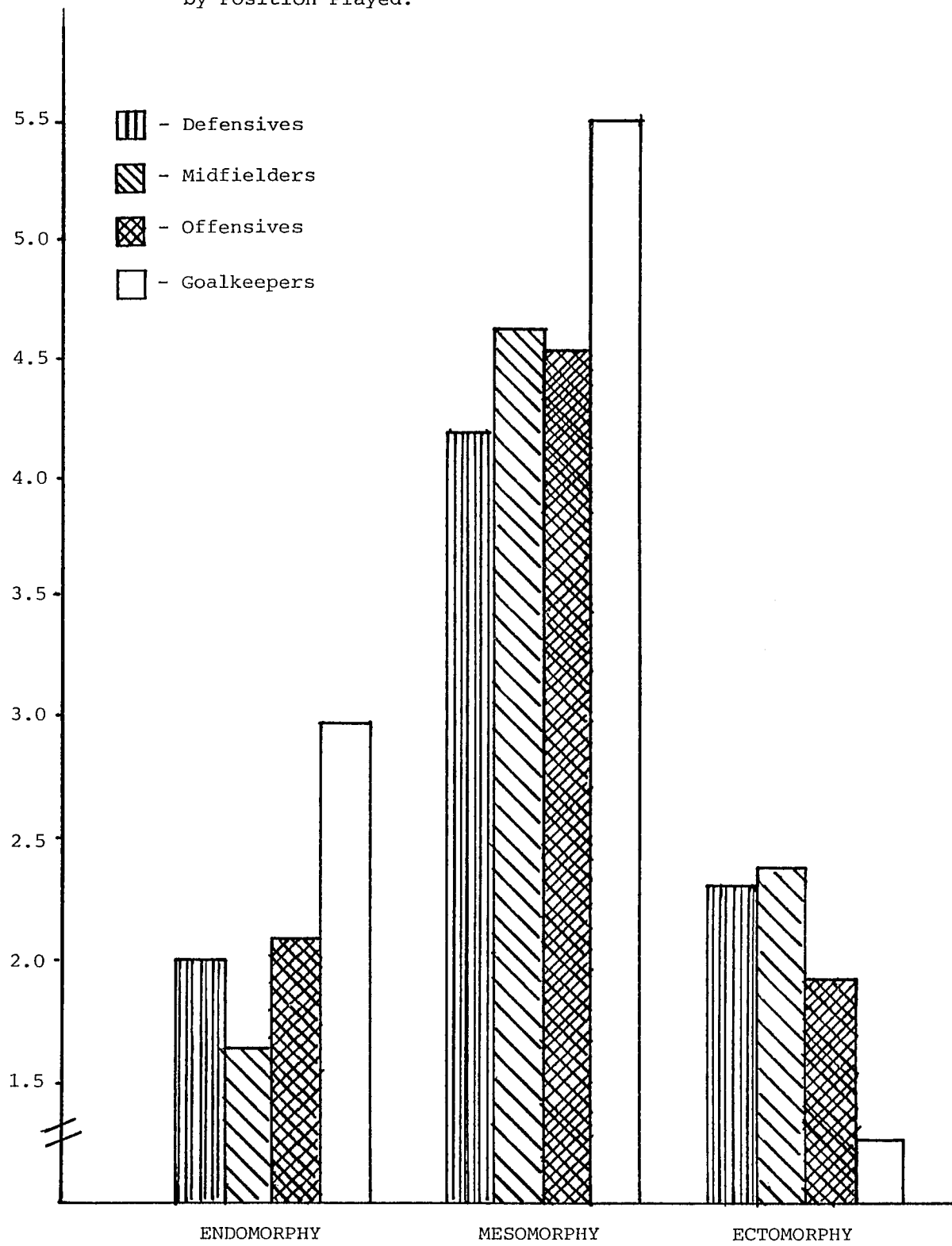




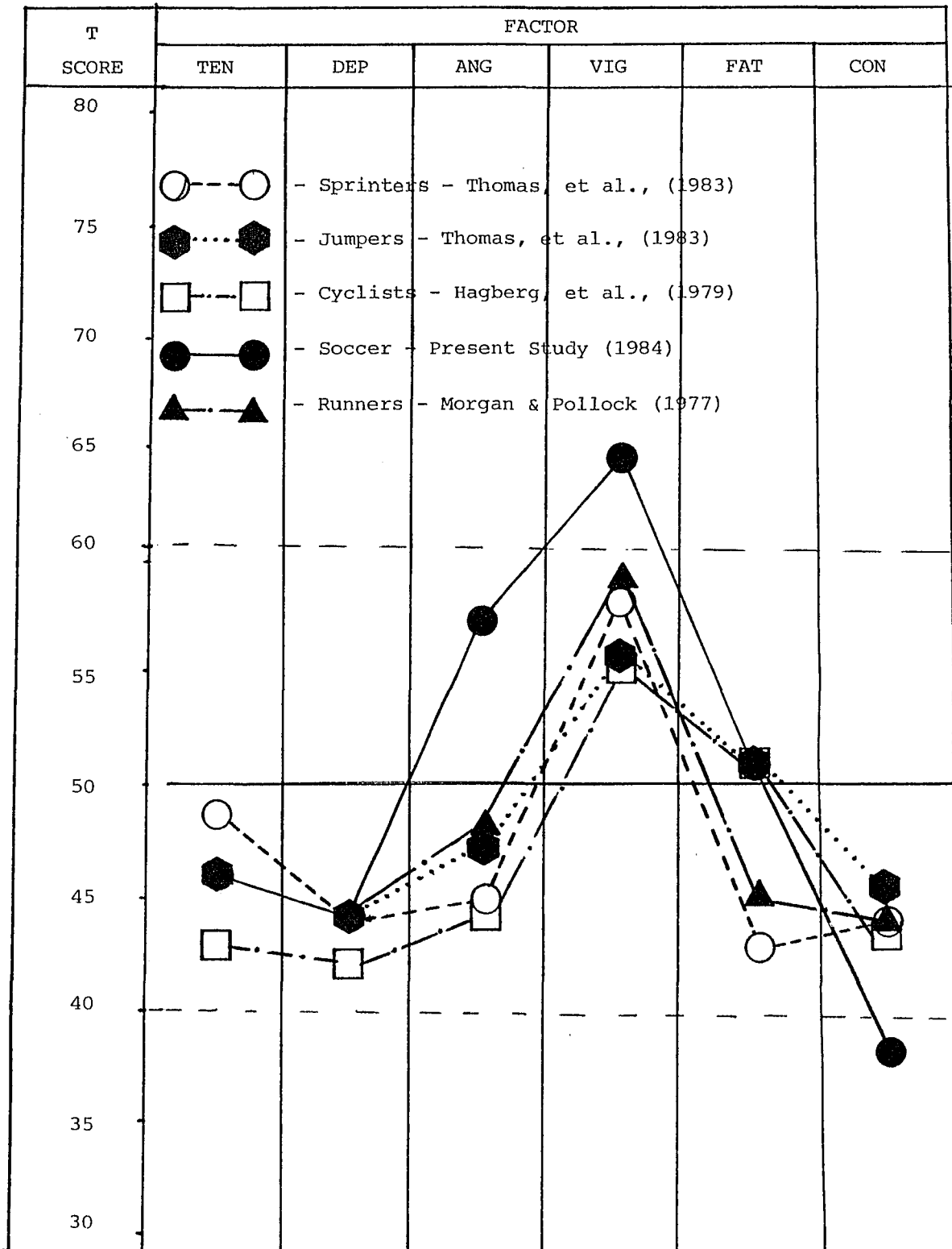
Table 10

Profile of Mood States and State-Trait Anxiety of Soccer Players -  
Differences Between the Starters and the Substitutes

<u>Subjects</u>	<u>N</u>	<u>Anxiety</u>		<u>Profile of Mood States</u>						
		<u>State</u>	<u>Trait</u>	<u>TEN</u>	<u>DEP</u>	<u>ANG</u>	<u>VIG</u>	<u>FAT</u>	<u>CON</u>	<u>TMD</u>
All Subjects	17	39.7 ±8.1	41.8* ±5.9	10.4* ±3.4	7.6** ±6.1	14.8** ±4.6	24.4** ±4.6	10.7 ±4.4	2.4** ±3.1	39.6 ----
Starters	8	42.6 ±8.4	43.0 ±6.1	11.5 ±2.7	8.9 ±4.9	15.3 ±3.7	26.0 ±5.7	10.4 ±4.5	4.0 ±3.2	42.8 ----
Substitutes	9	37.8 ±7.8	41.1 ±5.0	9.7 ±3.8	6.4 ±7.1	14.3 ±5.4	22.9 ±3.6	10.9 ±4.5	4.4 ±3.3	36.6 ----

\*Significant at 0.05 } Compared to college norms (Spielberger, et al., 1970;  
 \*\*Significant at 0.01 } McNair, et al., 1971)

Figure 10. Profile of Mood State in Various Sports.



state may be related to alleged inappropriate treatment of the players by some of the team officials; another factor might have been the long period of time (2.5 months) that the athletes spent out of their country, away from home, families, and businesses, being involved in strenuous friendly matches continuously with little or no breaks or rest intervals. The investigator's personal interviews with some of the players led to these explanations. One player mentioned how much he missed his family and children; another expressed the financial loss he was encountering while being in Spain. Furthermore, many athletes complained about the unacceptable treatment from some of the team officials that led to their anger and hostile feelings. For example, one official lost his temper and yelled at an important starter simply because the player wanted to change to another size shorts prior to a crucial match against France. Later that same player was replaced because of his poor performance. These and other typical coach versus players problems (Sturlesi & Antonelli, 1979) and interpersonal conflicts among the players (Salvini & Antonelli, 1979) may have contributed to the negative psychological effects on the players, and consequently hindered their performance.

The France versus Kuwait match was crucial for both teams, the winner to be qualified for the next round, so there was

enormous pressure on players from both sides. That day, prominent officials from neighboring countries, in addition to Kuwait's officials, visited the Kuwait athletes' locker room and bombarded them with great promises and expectations which may have provoked extreme arousal. The players entered the soccer field with apparent anxiety and tension. During the game, the Kuwaiti team appeared confused, often focused their attention on the referee's decisions, and were devastated during the match, losing by a score of four to one.

In looking at the Kuwait group results (Table 11), we observe that France lost one to three against England, whereas Kuwait lost zero to one against the same team, and both tied with Czechoslovakia. From these scores, it appears that the Kuwaiti, French, and the Czechoslovakian teams had performed on much the same level before the Kuwait versus France match. However, it is interesting that the Kuwaiti team lacked a professional psychologist, while both the French and Czechoslovakian teams had sport psychologists working with them and may have been better prepared psychologically. A sport psychologist mediates in moments of conflict, helps reduce competitive anxiety, and makes the business of competing a pleasurable one (Hogg, 1980; Salmela, et al., 1979). Managers and coaches should, therefore, understand the importance of psychology to enhance their leadership and their

Table 11  
The Results of the Kuwaiti Group in  
the 1982 World Cup Championship

Teams	England	France	Czechoslovakia	Kuwait
England	-----	3/1 <sup>a</sup>	2/0	1/0
France	1/1 <sup>b</sup>	-----	1/1	4/1
Czechoslovakia	0/0	0/0	-----	1/1
Kuwait	0/1	0/2	0/1	-----
Points	6	3	2	1

a-Upper level shows the final scores.

b-Lower level shows the first half scores.

relationship with the players, to safeguard the players' mental health, and to create a proper atmosphere for optimal performance (Antonelli, 1979).

Champion and top level athletes that have been studied (Hagberg, et al., 1979; Morgan, 1979; Morgan & Pollock, 1977; Thomas et al., 1983) have been overwhelmingly characterized as being more vigorous than the normal non-athletes. The world class soccer players from Kuwait were no different, and in fact were exceptionally high in this characteristic. Their lower confusion score might be related to the clear common goal - the World Cup Championship.

Every sport has psychological problems, but those occurring in soccer are more frequent and serious, particularly at the elite level. Antonelli (1979) attributed the mass media, fans, socio-economical factors, and sport and non-sport motivations to increased soccer problems. The French delegation engaged in a subtle psychological warfare before their match against Kuwait. An example was that they announced that they expected that Kuwait and England would remain in contention after the following round. Moreover, a statement that the French coach had substituted for five starters gave the impression that the French team was not prepared and that they had internal problems. This led other players, officials, mass media, and the fans to expect a win from

Kuwait. Consequently, the Kuwaiti team was psychologically convinced that they would win the match easily. However, this was not the case as they were confronted with an obviously confident, aggressive, well prepared French team, thereby creating confusion and anxiety. The French team subsequently advanced to the quarter finals and lost to Germany in overtime.

Soccer players revealed the highest state and trait anxiety level when compared with runners, sprinters, jumpers and college norms (Figure 11). Soccer players, jumpers, and college students showed higher trait anxiety than state anxiety, whereas sprinters and runners were the reverse.

The starters were higher in both state and trait anxiety than the substitutes, the state anxiety being more pronounced (Figure 12). Because only two players were allowed to substitute during the entire match, there was less burden upon the substitutes and they revealed a better psychological state than did the starters. This was illustrated by consistent differences in each category of POMS (Figure 12) as well as by state and trait anxiety differences.

By subdividing the team into positional groupings (Figure 13), it was found that the offensive players scored lower in trait anxiety, tension, depression, anger, and confusion. This may have been due to the nature of their tough minded roles which demand

Figure 11. State-Trait Anxiety Comparison of Various Sports.

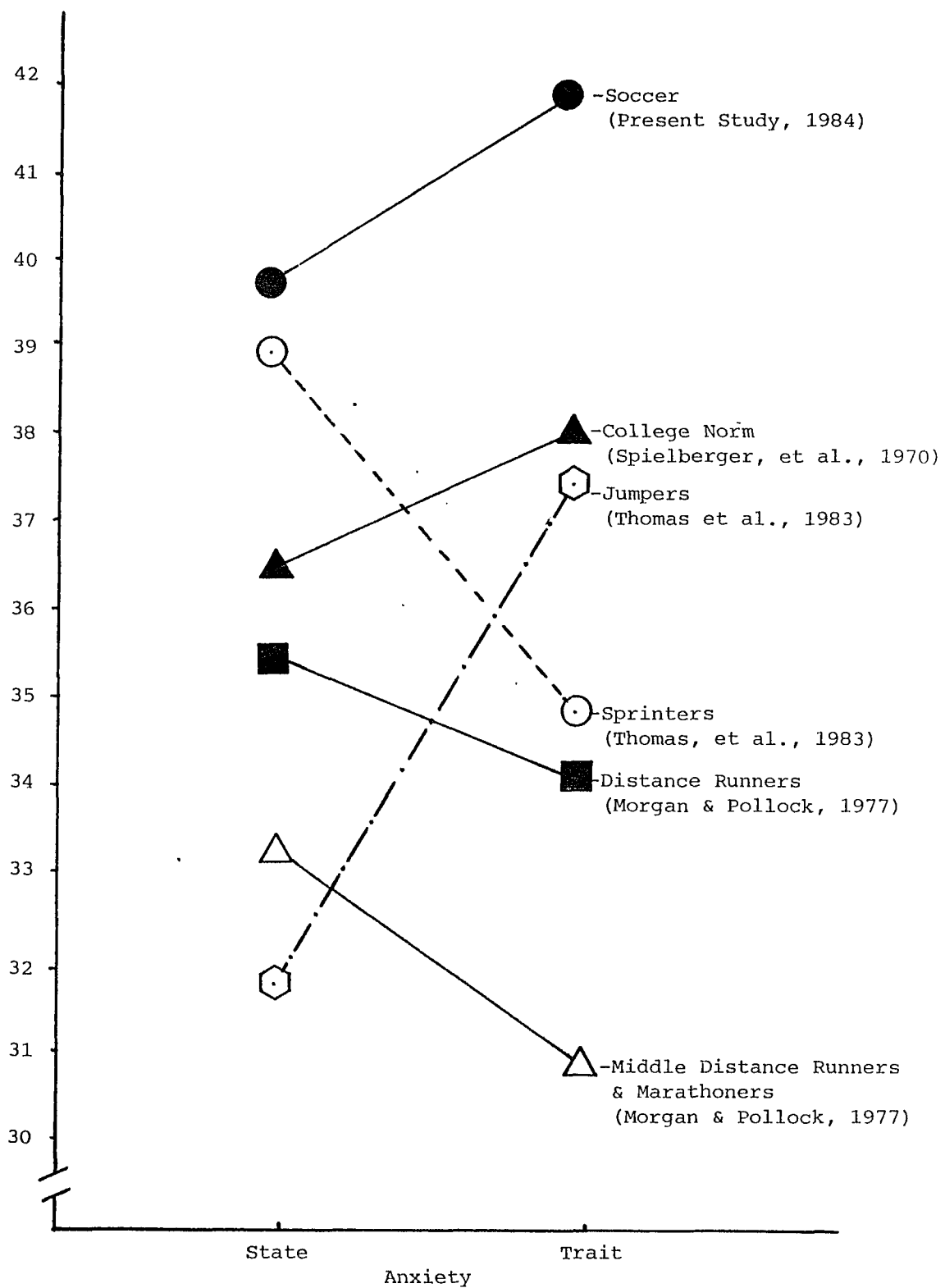




Figure 12. Profile of Mood States and State-Trait Anxiety

Differences Between the Starters and the Substitutes  
of the Kuwaiti World Cup Soccer Players.

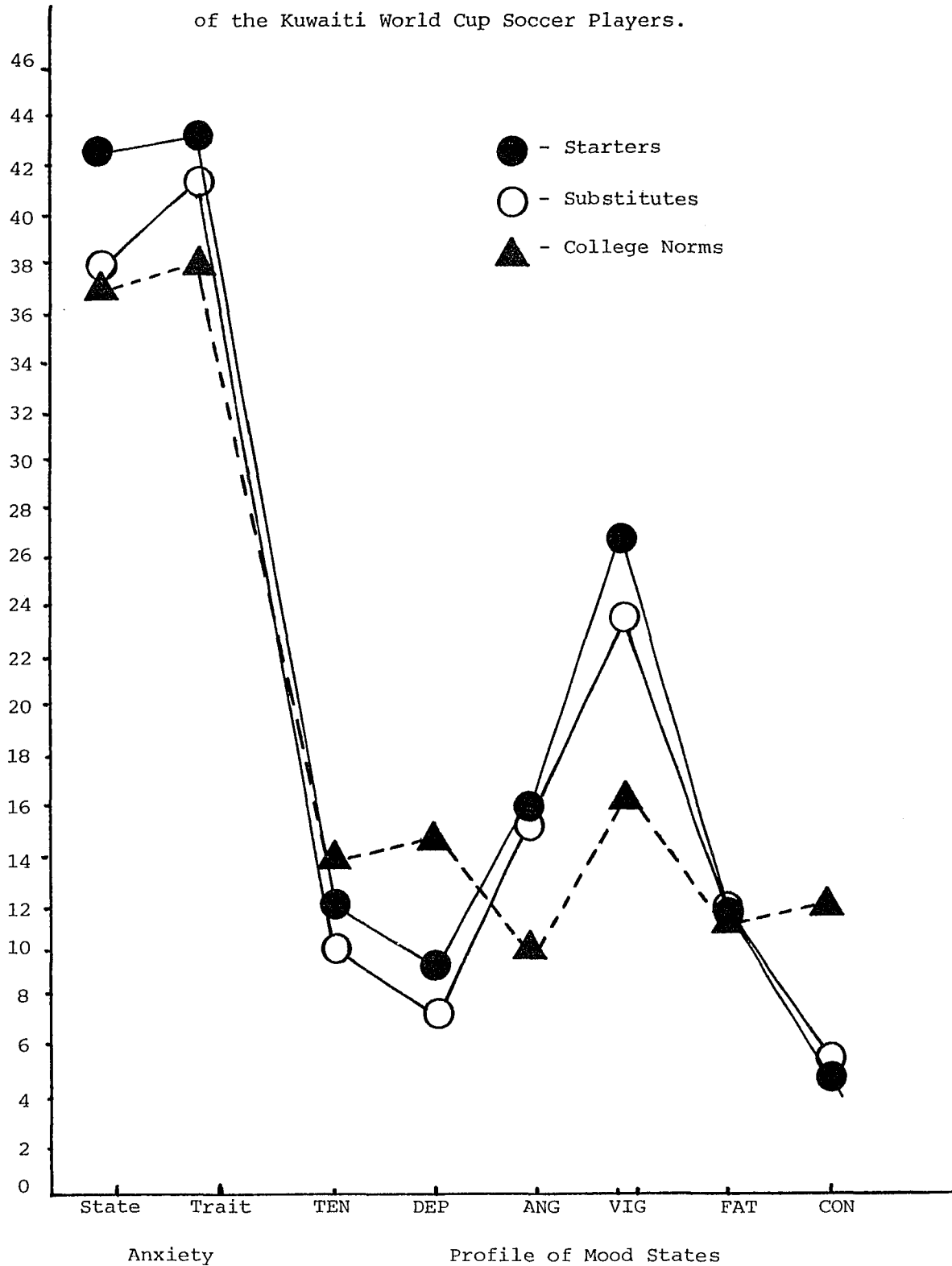
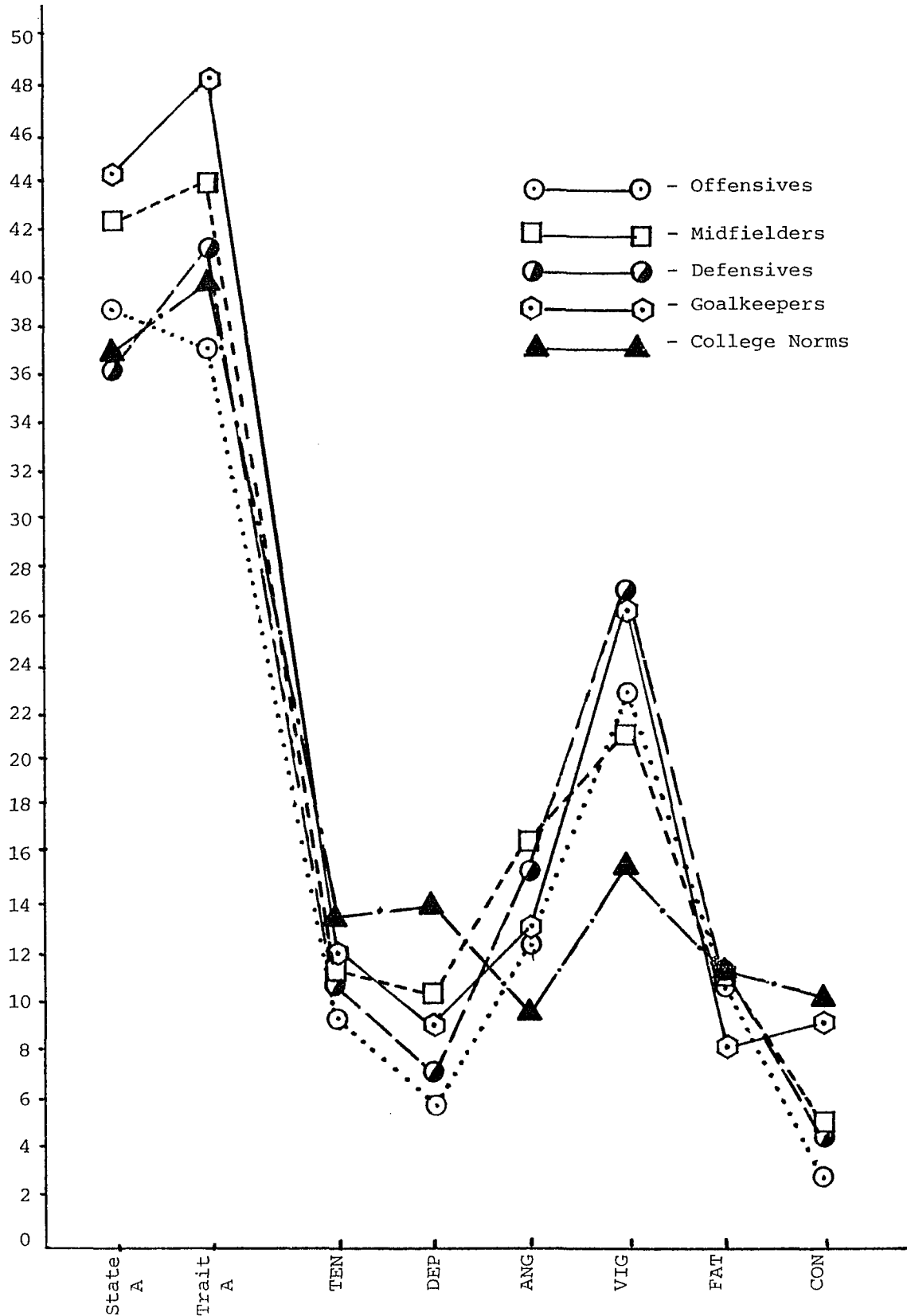


Figure 13. State-Trait Anxiety and Profile of Mood States

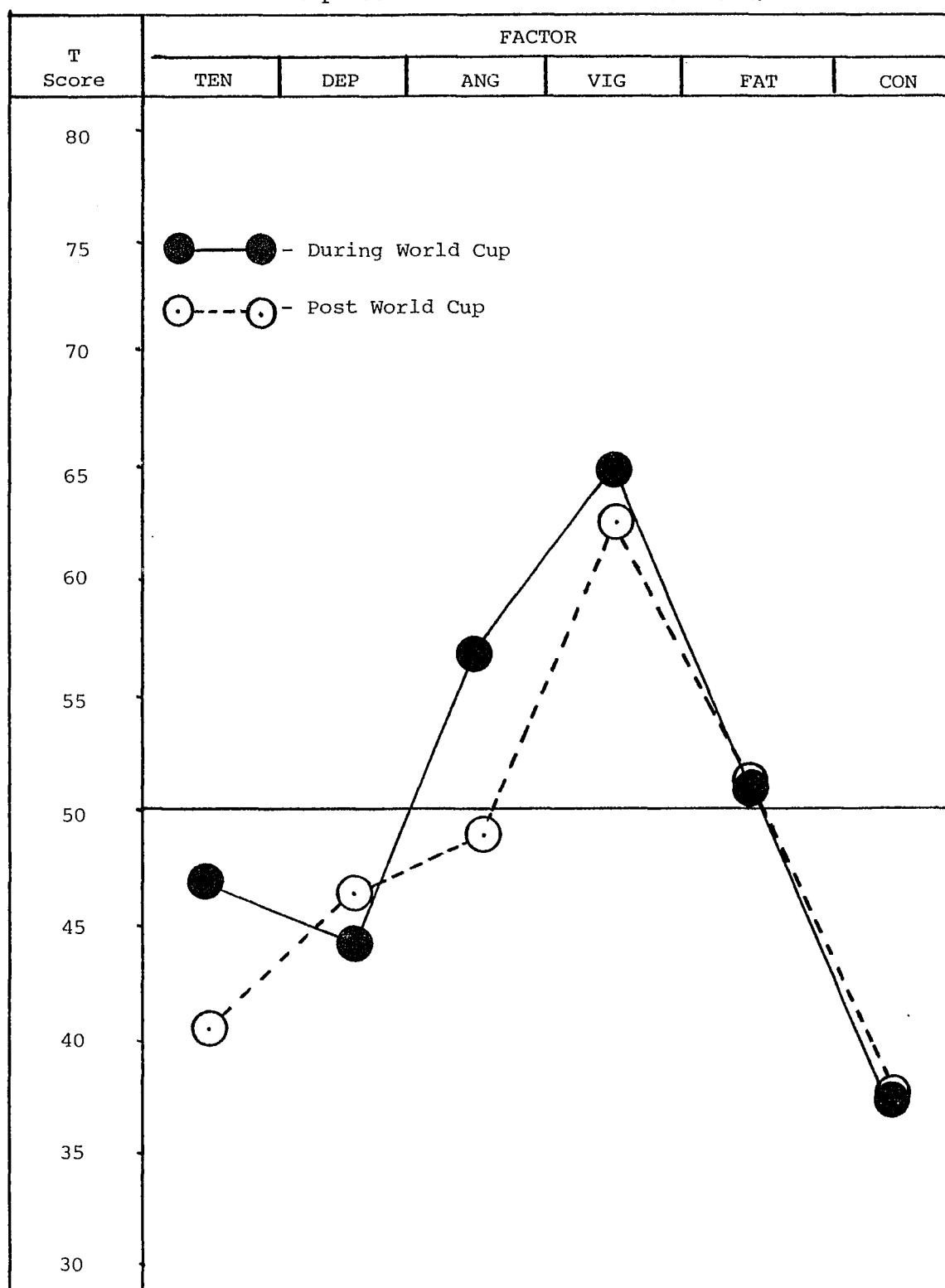
Comparison of the Kuwaiti Soccer Team by Position.



psychological readiness to score. As one might expect, goalkeepers had the highest state and trait anxiety levels. There was a significant difference in trait anxiety and confusion between the goalkeepers and the offensive players, but no significant difference appeared among the other positions. Goalkeepers feel a great responsibility to prevent being scored upon, and their errors are often more visible and almost always more critical than those of other players. The midfielders, defensives, and the goalkeepers showed higher trait anxiety than state anxiety, and the offensive players had higher state anxiety. Any explanations of these differences would necessarily be conjectural.

POMS factors comparison of scores during versus 18 months after the World Cup games (Figure 14) revealed significantly lower tension factor at the second testing period. The players after the games were less tense because of the reduction of pressure in less important competitions. More interestingly, the anger characteristic of the players was significantly reduced in the post World Cup test compared to during the World Cup. This might be explained by the less stressful treatment by coaches and other officials, and by being back with their families, peers, and businesses. No significant differences appeared in depression, vigor, fatigue, or confusion factors between the two tests,

Figure 14. Comparison of Profile of Mood States During and Post the World Cup Soccer Games of the Kuwaiti Team.



### Summary and Conclusions

Members of the 1982 Kuwait World Cup Soccer Team exhibited moderately high anaerobic ( $119.6 \text{ kg}\cdot\text{m}/\text{sec}^{-1}$ ) and aerobic ( $51.9 \text{ ml}/\text{kg}\cdot\text{min}^{-1}$ ) power, both values being in the mid-ranges for world-class athletes in general. Relative body fatness (8.9%), low when compared to the normal population, was similar to that of other athletes participating in team sports in high-level competition. The team was characterized by a balanced mesomorphic somatotype (2.1-4.5-2.1). As evaluated by POMS, athletes are generally more vigorous than nonathletes. The Kuwaiti soccer players were no different, except for scoring significantly higher on the anger factor. On followup testing 18 months after the World Cup Games, this factor was determined to be normal. Finally, according to results of STAI, the Kuwaiti team was characterized as being high in both state and trait anxiety, even when compared to other athletes. There were no significant correlations between physiological-anatomical and psychological data.

Several significant differences appeared when analysis by playing position was accomplished. Compared to players at other positions, goalkeepers had lower aerobic power, high anaerobic power, a higher percentage of body fat, higher mesomorphic components, and both higher state and trait anxiety levels.

Midfielders were the leanest players and had the highest aerobic power. Offensives exhibited the lowest levels of tension, depression, anger, confusion, and trait anxiety. The primary differentiating characteristic of defensives was a high anaerobic power, comparable to that of the goalkeepers. Compared to the substitutes, starters were significantly older, less fat, and were higher in both state and trait anxiety.

In conclusion, it would appear that the structural and functional measures taken for this study indicate that the Kuwaiti Team had appropriate potential for World Cup competition. Excessively high state anxiety, trait anxiety, and anger indicates less than optimal psychological preparation for the task. It is therefore recommended:

1. the structural and functional characteristics of world class soccer players be validated by making similar measures on one of the outstanding European World Cup Teams.

2. that determinations of skeletal muscle fiber types, biochemical characteristics, and more sophisticated anatomic analyses be carried out to further extend knowledge of the makeup of world class soccer athletes.

3. that such future studies should include an examination of a broader spectrum of psychological variables.

4. that for world class competition, an exercise physiologist and a sport psychologist be included as an integral part of a multidisciplinary management team.

#### BIBLIOGRAPHY

- Antonelli, F. Psychological problems of football players. International Journal of Sport Psychology, 1970, 10, 60.
- Åstrand, I. Aerobic work capacity in men and women with special reference to age. Acta Physiologica Scandinavica, 1960, 49, (Suppl. 169).
- Åstrand, P. O. New records in human power. Nature, 1955, 176, 922-923.
- Åstrand, P. O., & Rodahl, K. Textbook of Work Physiology. New York: McGraw-Hill, 1977.
- Åstrand, P. O., & Saltin, B. Maximal oxygen uptake and heart rate in various types of muscular activity. Journal of Applied Physiology, 1961, 16, 977-981.
- Balke, B., & Ware, R. An experimental study of physical fitness of air force personnel. U.S. Armed Forces Medical Journal, 1959, 10, 675.
- Bangerter, B. L. Contributive components in the vertical jump. Research Quarterly, 1968, 39, 432-436.
- Beckenholdt, S. E., & Mayhew, J. L. Specificity among anaerobic power test in male athletes. Journal of Sports Medicine and Physical Fitness, 1983, 23, 326-332.
- Behnke, A. R., & Royce, J. Body size, shape and composition of several types of athletes. Journal of Sports Medicine and Physical Fitness, 1966, 6, 75-88.
- Bell, W. Body composition and maximal aerobic power of rugby union forwards. Journal of Sports Medicine and Physical Fitness, 1980, 20, 447-451.



- Bell, W., & Rhodes, G. The morphological characteristics of the association football players. British Journal of Sports Medicine, 1975, 9, 196-200.
- Bergh, M., & Ekblom, B. Physical performance and peak aerobic power at different body temperatures. Journal of Applied Physiology, 1979, 46, 885-889.
- Blumenthal, J. A., Williams, R. S., Needels, T. L., & Wallace, A. G. Psychological changes accompany aerobic exercise in healthy middle-aged adults. Psychosomatic Medicine, 1982, 44(6), 529-536.
- Blumenstein, B., & Hudanov, N. Psychological preparation for competition. Soviet Sports Review, 1980, 15, 1-4.
- Bruce, R. A., Blackman, J. R., & Jones, J. W. Exercise testing in adult normal subjects and cardiac patients. Pediatrics, 1963, 32, 742-755.
- Brunner, B. C. Personality and motivating factors influencing adult participation in vigorous physical activity. Research Quarterly, 1969, 40, 464-469.
- Bryntenson, P., & Sinning, W. E. The effects of training frequencies on the retention of cardiovascular fitness. Medicine and Science in Sports, 1973, 5, 29-33.
- Burke, E. J., Winslow, E., & Strube, W. V. Measures of body composition and performance in major college football players. Journal of Sports Medicine and Physical Fitness, 1980, 20, 173-180.

- Byrd, R., & Collins, M. Physiologic characteristics of fire fighters. American Corrective Therapy Journal, 1980, 34, 106-109.
- Cabrera, J. M., Smith, D. P., & Byrd, R. J. Cardiovascular adaptations on Puerto Rican basketball players during a 14-week season. Journal of Sports Medicine and Physical Fitness, 1977, 17, 173-180.
- Carron, A. Reactions to anxiety and motor behavior. Journal of Motor Behavior, 1971, 3, 181-188.
- Carter, J. E. L. The somatotypes of college football players. Research Quarterly, 1968, 39, 466-481.
- Carter, J. E. L. The Heath-Carter Somatotype Method. San Diego State University, San Diego, California, 1957.
- Carter, J. E. L. The somatotypes of college football players. Research Quarterly, 1968, 39, 466-481.
- Carter, L. The somatotypes of athletes. Human Biology, 1970, 42, 535-569.
- Caru, B., Le Coultre, L., Aghemo, P., & Pinera Limas, F. Maximal aerobic and anaerobic muscular power in football players. Journal of Sports Medicine and Physical Fitness, 1970, 10, 100-103.
- Clark, H. H. Muscular power of the legs. Physical Fitness Research Digest, 1978, (8, Serial No. 2).
- Conlee, R. K., McGown, C. M., Fisher, A. G., Dalsky, G. P., & Robinson, K. C. Physiological effects of power volleyball. The Physician and Sportsmedicine, 1982, 10(2), 93-97.

- Considine, W. J., & Sullivan, W. J. Relationship of selected test of leg strength and leg power on college men. Research Quarterly, 1973, 44 (4), 404-416.
- Costill, D. Championship material. Runner's World, 1974, 9, 26-27.
- Costill, D. L. Metabolic responses during distance running. Journal of Applied Physiology, 1970, 28(3), 251-255.
- Costill, D. L., Bowers, R., & Kammer, W. F. Skinfold estimates of body fat among marathon runners. Medicine and Science in Sports, 1970, 2(2), 93-95.
- Costill, D. L., & Fox, E. L. Energetics of marathon running. Medicine and Science in Sports, 1969, 1(2), 81-86.
- Costill, D. L., Hoffman, W. M., Kehoe, F., Miller, S. J., & Myers, W. C. Maximum anaerobic power among college football players. Journal of Sports Medicine and Physical Fitness, 1968, 8 (2), 103-106.
- Costill, D. L., Miller, S. J., Myers, W. C., Kehoe, F. J., & Hoffman, W. M. Relationship among selected tests of explosive leg strength and power. Research Quarterly, 1968, 39 (3), 785-787.
- Cureton, K. J., Sparling, P. B., Evans, B. W., Johnson, S. M., Kong, V. D., & Purvis, J. W. Effects of experimental alterations in excess weight on aerobic capacity and distance running performance. Medicine and Science in Sports, 1978, 3, 194-199.
- Cureton, T. K. Physical fitness of champion athletes. University of Illinois Press: Urbana, 1951.

- Di Prampero, P. E., Pinera Limas, F., & Sasi, G. Maximal muscular power, aerobic and anaerobic, in 116 athletes performing at the XIXth Olympic games in Mexico. Ergonomics, 1970, 13, 665-674.
- Durnin, J. V., & Rahaman, M. M. The assessment of the amount of fat in the human body from measurements of skinfold thickness. British Journal of Nutrition, 1967, 21, 681-689.
- Ellestad, M. H., Allen, W., Wan, M. C., & Kemp, G., Maximal treadmill stress testing for cardiovascular evaluation. Circulation, 1969, 39, 517.
- Encyclopaedia Britannica. Macropaedia Knowledge in Depth, Helen Hemingway Benton, Chicago: 1978, p. 210.
- Evans, J. A., & Quinney, H. A. Determination of resistance settings for anaerobic power testing. Canadian Journal of Applied Sport Sciences, 1981, 6 (2), 53-56.
- Eysenck, H. J., & Eysenck, S. B. Manual for the Eysenck Personality Inventory. San Diego: Educational and Industrial Testing Service, 1968.
- Fahey, T. D., Akka, L., & Rolph, R. Body composition and  $\dot{V}O_2$  max of exceptional weight-trained athletes. Journal of Applied Physiology, 1975, 39(4), 559-561.
- Fardy, P. S. Effects of soccer training and detraining upon selected cardiac and metabolic measures. Research Quarterly, 1969, 40(3), 502-508.

- Faris, A. W., Gilley, W. F., Dean, G. M., & Teh, K. C. Physiological profiles of world class decathlon athletes in training. Journal of Sports Medicine and Physical Fitness, 1980, 20, 285-290.
- Farmosi, I. Body-composition, somatotype and some motor performance of judoists. Journal of Sports Medicine and Physical Fitness, 1980, 20, 431-435.
- Faulkner, J., Kollias, J., Favour, C., Buskirk, E., & Balke, B. Maximum aerobic capacity and running performance at altitude. Journal of Applied Physiology, 1968, 24(5), 685-691.
- Faulkner, J. A., Roberts, D. E., Elk, R. L., & Conway, J. Cardiovascular responses to submaximum and maximum effort cycling and running. Journal of Applied Physiology, 1971, 30, 457-461.
- Fenz, W. D., & Jones, G. B. Individual differences in physiologic arousal and performance in sport parachutist. Psychosomatic Medicine, 1972, 34(1), 1-8.
- Forsyth, H. L., & Sinning, W. E. the anthropometric estimation of body density and lean body weight of male athletes. Medicine and Science in Sports, 1973, 5(3), 174-180.
- Fox, E. L., Bartels, R. L., Klinzing, J. & Ragg, K. Metabolic responses to interval training programs of high and low power and output. Medicine and Science in Sports, 1977, 9 (3), 191-196.

- Fox, E. L., & Mathews, D. K. The Physiological Basis of Physical Education and Athletics (3rd ed.). Philadelphia: W. B. Saunders, 1981, 621.
- Froelicher, V. F., Jr., Brammell, H., Davis, G., Noguera, I., Stewart, A., & Lancaster, M. C. A comparison of three maximal treadmill exercise protocols. Journal of Applied Physiology, 1974, 36(4), 720-725.
- Gettman, L. R., Ayres, J. J., Pollock, M. L., & Jackson, A. The effect of circuit weight training on strength, cardiorespiratory function, and body composition of adult men. Medicine and Science in Sports, 1978, 10, 171-176.
- Glassford, R. G., Baycroft, G. H., Sedgwick, A. W., & MacNab, R. B. Comparison of maximal oxygen uptake values determined by predicted and actual methods. Journal of Applied Physiology, 1965, 20, 509-513.
- Goldman, R. F., & Buskirk, E. R. Body volume measurement by underwater weighing: description of a method. Techniques for Measuring Body Composition. Washington, D.C.: National Academy of Science - National Research Council, 1961, 78-89.
- Gould, D., Weiss, M., & Weinberg, R. Psychological characteristics of successful and unsuccessful big ten wrestlers. Journal of Sport Psychology, 1981, 3, 69-81.
- Gray, H. Body build in football players. Research Quarterly, 1936, 7(3), 47-57.

- Griffiths, T. J., Steel, D. H., Vaccaro, P. Relationship between anxiety and performance in scuba diving. Perceptual and Motor Skills, 1979, 48 (3), 1009-1010.
- Griffiths, T. J., Steel, D. H., Vaccaro, P., & Karpman, M. B. The effects of relaxation techniques on anxiety and underwater performance. International Journal of Sports Psychology, 1981, 12, 176-182.
- Gruber, J. J., & Beauchamp, D. Relevancy of the competitive state anxiety inventory in a sport environment. Research Quarterly, 1979, 50(2), 207-214.
- Guvov, V. M., Svyadoshch, A. M., & Tampolsky, L. T. The suggestive method of preparing athletes for competition. Soviet Sports Review, 1980, 15 (2), 53-56.
- Hagberg, J. M., Mullin, J. P., Bahrke, M., & Limburg, J. Physiological profiles and selected psychological characteristics of national class American cyclists. Journal of Sports Medicine and Physical Fitness, 1979, 19, 341-346.
- Harsha, D. W., Frerichs, R. R. & Berenson, G. S. A simple and complete densitometric technique for underwater weighing. Journal of Sports Medicine and Physical Fitness, 1978, 18, 253-262.
- Heath, B. H. Need for modification of somatotype methodology. American Journal of Physical Anthropology, 1965, 23, 135-142.

- Heath, B. H., & Carter, J. L. A modified somatotype method. American Journal of Physical Anthropology, 1967, 27, 57-74.
- Hermansen, L., Ekblom, B., & Saltin, B. Cardiac output during submaximal and maximal treadmill and bicycle exercise. Journal of Applied Physiology, 1970, 29, 82-86.
- Hickson, R. C., Bomze, H. A., & Holloszy, J. O. Faster adjustment of O<sub>2</sub> uptake to the energy requirement of exercise in the trained state. Journal of Applied Physiology, 1978, 44, 877-881.
- Hirata, K. I. Physique and age of Tokyo olympic champions. Journal of Sports Medicine and Physical Fitness, 1966, 6, 207-222.
- Hodges, W. Effects of ego threat and threat of pain on state anxiety. Journal of Personality and Social Psychology, 1968, 8, 264-273.
- Hodges, W., & Spielberger, C. Digit span: An indicant of trait or state anxiety. Journal of Consulting and Clinical Psychology, 1969, 33, 430-434.
- Hogg, J. M. Anxiety and the competitive swimmers. Canadian Journal of Applied Sports Sciences, 1980, 5(3), 183-187.
- Holmer, I., Lundin, A., & Eriksoon, B. O. Maximum oxygen uptake during swimming and running by elite swimmers. Journal of Applied Physiology, 1974, 36, 711-714.
- Huddleston, S., & Gill, D. L. State anxiety as a function of skill level and proximity to competition. Research Quarterly, 1981, 52(1), 31-34.



- Imlay, R. C. The physiques of college baseball players in San Diego, California. M.A. Thesis, San Diego State College, 1966.
- Jackson, A. S., & Pollock, M. L. Generalized equations for predicting body density of men. British Journal of Nutrition, 1978, 40, 497-504.
- Johnson, B. L., & Nelson, J. K. Practical Measurements for Evaluation in Physical Education (3rd ed.). Minneapolis: Burgess, 1979.
- Kalamen, J. Measurement of maximum muscular power in man. Ph D. thesis, Ohio State University, Columbus, Ohio, 1968.
- Kansal, D. K., Verma, S. K., & Sidhu, L. S. Intrasportive differences in maximum oxygen uptake and body composition of Indian players in hockey and football. Journal of Sports Medicine and Physical Fitness, 1980, 20, 309-316.
- Kasch, F. W., Wallace, J. P. Physiological variable during 10 years of endurance exercise. Medicine and Science in Sports, 1976, 8(1), 5-8.
- Katch, F. I., & Michael, E. D., & Horvath, S. M. Estimation of body volume by underwater weighing: description of a simple method. Journal of Applied Physiology, 1967, 23(5), 811-813.
- Kroll, W., & Peterson, K. H. Personality factor profiles of collegiate football teams. Research Quarterly, 1965, 36(4), 433-438.
- Leslie, J., Byrd, R., & Collins, M. Somatotypes of young female gymnasts. University of Alabama, Birmingham Education Review, 1977, 2, 133-138.

- Lever, J. Soccer Madness. The University of Chicago Press, Chicago: 1983, p. 20.
- MacDougall, J. D., Ward, G. R., Sale, D. J., & Sutton, J. R. Biochemical adaptation of human skeletal muscle to heavy resistance training and immobilization. Journal of Applied Physiology, 1977, 43(4), 700-703.
- Magel, J. R., & Faulkner, J. A. Maximum oxygen uptake of college swimmers. Journal of Applied Physiology, 1967, 22, 929-933.
- Mahoney, M. J., & Avenier, M. Psychology of the elite athlete: An exploratory study. Cognitive Therapy and Research, 1977, 1(2), 135-141.
- Mann, G. V., Garrett, H. L., Farhi, A., Murray, H., & Billings, F. T. Exercise to prevent coronary heart disease. American Journal of Medicine, 1969, 46, 12-27.
- Margarita, R., Aghemo, P., & Rovelli, E. Measurement of muscular power (anaerobic) in man. Journal of Applied Physiology, 1966, 21 (5), 1662-1664.
- Margarita, R., Cerretelli, P., & Mangili, F. Balance and kinetics of anaerobic energy release during strenuous exercise in man. Journal of Applied Physiology, 1964, 19, 623-628.
- Martens, R., & Gill, D. State anxiety among successful and unsuccessful competitors who differ in competitive trait anxiety. Research Quarterly, 1976, 47(4), 698-708.

- Maud, P. J. Physiological and anthropometric parameters that describe a rugby union team. British Journal of Sports Medicine, 1983, 17, 16-23.
- McArdle, W. D., Katch, F. I., & Katch, V. L. Exercise Physiology Energy, Nutrition, and Human Performance. Philadelphia: Lea & Febiger, 1981.
- McArdle, W. D., Katch, F. I., Pechar, G. S. Comparison of continuous and discontinuous treadmill and bicycle tests for max  $\dot{V}O_2$ . Medicine and Science in Sports, 1973, 5, 156-160.
- McClements, L. E. Power relative to strength of leg and thigh muscles. Research Quarterly, 1966, 37 (1), 71-78
- McCloy, C. H., & Young, N. C. Tests and Measurements in Health and Physical Education. New York: Appleton-Century-Crofts, 1954.
- McGlynn, G. H., Franklin, B., Lauro, G., & McGlynn, I. K. The effect of aerobic conditioning and induced stress on state-trait anxiety, blood pressure, and muscle tension. Journal of Sports Medicine and Physical Fitness, 1983, 23, 341-351.
- McKenzie, D. C., Parkhouse, W. S., Rhodes, E. C., Hochochka, P.W., Ovalle, W. K., Mommsen, T. P., & Shinn, S. L. Skeletal muscle buffering capacity in elite athletes. In H. Knuttgen, J. Vogel, & T Poortmans (Eds.), International Series on Sports Sciences - Biochemistry of Exercise (Vol. 13). Champaign: Human Kinetics Publishers, 1983.
- McNair, D. M., Lorr, M., & Droppleman, L. F. Profile of Mood Status Manual. San Diego: Educational and Industrial Testing Service, 1971.

Metheny, E. Some differences in bodily proportions between American negro and white male college students as related to athletic performance.

Research Quarterly, 1939, 10(4), 41-53.

Mickelson, T. C., & Hagerman, F. C. Anaerobic threshold measurements of elite oarsmen. Medicine and Science in Sports and Exercise, 1982, 14, 440-444.

Miller, L. World Cup - or World War? New York Times Magazine, May 1978, 21, 20-22, 63-69.

Morgan, W. P. Exercise and Mental Disorders in Sports Medicine. A. J. Ryan & F. L. Allman, Jr. (Eds.), Academic Press: New York, 1974, 671-679.

Morgan, W. P. Personality characteristics of wrestlers participating in world championships. Journal of Sports Medicine and Physical Fitness, 1968, 8, 212-216.

Morgan, W. P. Physical fitness and emotional health: A review. American Corrective Therapy Journal, 1969, 23, 124-127.

Morgan, W. P. Prediction of performance in athletics. In P. Klovora & J. Daniels (Eds.), Coach, Athletes, and the Sport Psychologist. Champaign, IL.: Human Kinetics, 1979.

Morgan, W. P. Pre-match anxiety in a group of college wrestlers. International Journal of Sport Psychology, 1970, 1, 7-13.

Morgan, W. P. Psychology of Sports Competition. In A. J. Ryan & F. L. Allman, Jr. (Eds.), Sports Medicine, Academic Press: New York, 1974, 129-140.

- Morgan, W. P. Selected physiological and psychomotor correlates of depression in psychiatric patients. Research Quarterly, 1968, 39(4), 1037-1043.
- Morgan, W. P. Selected psychological considerations in sport. Research Quarterly, 1974, 45(4), 374-390.
- Morgan, W. P. & Costill, D. L. Psychological characteristics of the marathon runner. Journal of Sports Medicine and Physical Fitness, 1972, 12, 42-46.
- Morgan, W. P., & Hammer, W. M. Influence of competitive wrestling upon state anxiety. Medicine and Science in Sports, 1974, 6, 58-61.
- Morgan, W. P. & Pollock, M. L. Psychologic characterization of the elite distance runner. Annals of the New York Academy of Sciences, 1977, 301, 382-403.
- Morgan, W. P., Roberts, J. A., Brand, F. R., & Feinerman, A. D. Psychological effect of chronic physical activity. Medicine and Science in Sports, 1970, 2(4), 213-217.
- Moulds, B., Carter, D. R., Coleman, J., & Stone, M. Physical responses of a women's basketball team to a pre-season conditioning program. Science in Sports, J. Terauds, Ed., 1979, 203-210.
- Naughton, J., Bruhn, J. G., & Lategola, M. T. Effects of physical training on physiologic and behavioral characteristics of cardiac patients. Archives of Physical Medicine and Rehabilitation, 1968, 49, 131-137.

- Nelson, J. K., & Dorociak, J. Comparative analysis of power measurements in men and women. Paper presented at AAHPERD Convention, Boston, MA, 1981.
- Ness, P.E., & Sharos, C. L. The effect of weight training on leg strength and vertical jump. Master's thesis, Springfield College, 1956.
- Nideffer, R. M., & Deckner, C. W. A case study of improved athletic performance following use of relaxation procedures. Perceptual and Motor Skills, 1970, 30(3), 821-822.
- Novak, L. P., Bestit, C., Mellerowicz, H., & Woodward, W. A. Maximal oxygen consumption, body composition and anthropometry of selected olympic male athletes. Journal of Sports Medicine and Physical Fitness, 1978, 18, 139-150.
- O'Bryant, H. S. Periodization: A hypothetical training model for strength and power. A doctoral dissertation, Louisiana State University, 1982.
- Pascale, L. R., Grossman, M. I., Sloan, H. S., & Frankel, T. Correlation between thickness of skinfolds and body density in 88 (eighty-eight) soldiers. Human Biology, 1956, 28, 165.
- Pierce, C. M., Stillner, V., & Popkin, M. On the meaning of sports: cross cultural observations of super stress. Culture, Medicine and Psychiatry, 1982, 6, 11-28.
- Pollock, M. L., Bohannon, R. L., Cooper, K. H., Ayres, J. J., Ward, A., White, S. R., & Linnerud, A. C. A comparative analysis of four protocols for maximal treadmill stress testing. American Heart Journal, 1976, 92(1), 39-46.

- Pollock, M. L., Cureton, T. K., & Greninger, L. Effects of frequency of training on working capacity, cardiovascular function, and body composition in adult men. Medicine and Science in Sports, 1969, 1(2), 70-74.
- Pollock, M. L., Jackson, A. S., & Pate, R. R. Discriminate analysis of physiological differences between good and elite distance runners. Research Quarterly for Exercise and Sport, 1980, 51, 521-532.
- Pollock, M. L., Miller, H. S., & Wilmore, J. Physiological characteristics of champion American track athletes 40 to 75 years of age. Journal of Gerontology, 1974, 29(6), 645-649.
- Powell, F. M., & Verner, J. P. Anxiety and performance relationships in first time parachutists. Journal of Sport Psychology, 1982, 4, 184-188.
- Powers, S. K., Dodd, S., Deason, R., Byrd, R., & McKnight, T. Ventilatory threshold, running economy and distance running performance of trained athletes. Research Quarterly, 1983, 54(2), 179-182.
- Pugh, L. C. Animals in High altitudes. Man above 5000 meters mountain exploration. Handbook of Physiology. Eds.: Dill, D. B., Adolph, E. F., & Wilber, C. G. Baltimore: The Williams and Wilkins Co., 1964.
- Puhl, J., Case, S., Fleck, S., & Van Handel, P. Physical and physiological characteristics of elite volleyball players. Research Quarterly for Exercise and Sport, 1982, 53(3), 257-262.

- Raven, P. B., Gettman, L. R., Pollock, M. L., & Cooper, K. H. A physiological evaluation of professional soccer players. British Journal of Sports Medicine, 1976, 10(4), 209-216.
- Reid, R. M., & Hay, D. Some behavioral characteristics of rugby and association footballers. International Journal of Sports Psychology, 1979, 10(4), 239-251.
- Reilly, T. & Thomas, V. A motion analysis of work-rate in different positional roles in professional football match-play. Journal of Human Movement Studies, 1976, 2, 87-97.
- Robinson, S., Edwards, H. T., & Dill, D. B. New records in human power. Science, 1937, 85, 409-410.
- Salmela, J. H., Hosek, V., Janssen, J. P., Pilvein, M., & DaSilva, A. R. Psychological management of the top athletes. International Journal of Sport Psychology, 1979, 10(3), 156-163.
- Saltin, B. Metabolic fundamentals in exercise. Medicine and Science in Exercise, 1973, 5(3), 137-146.
- Saltin, B., & Åstrand, P. O. Maximal oxygen uptake in athletes. Journal of Applied Physiology, 1967, 23(3), 353-358.
- Salvini, A. & Antonelli, F. Group dynamics and sport performance. International Journal of Sport Psychology, 1979, 10, 63.
- Sanderson, F. H., & Ashton, M. K. Analysis of anxiety levels before and after badminton competition. International Journal of Sport Psychology, 1981, 12, 23-28.



- Sanderson, F. H., & Reilly, T. Trait and state anxiety in male and female cross-country runners. British Journal of Sports Medicine, 1983, 17 (1), 24-26.
- Sharkey, B. J. Physiology of Fitness. Champaign: Human Kinetics, 1979.
- Sharp, R. L., Armstrong, L. E., King, D. S., & Costill, D. L. Buffer capacity of blood in trained and untrained males. In H. Knuttgen, J. Vogel, & J. Poortmans (Eds.), International Series on Sport Sciences Biochemistry of Exercise (Vol. 13). Champaign: Human Kinetics Publishers, 1983.
- Shaver, L. G. Body composition, endurance capacity and strength of college lacrosse players. Journal of Sports Medicine and Physical Fitness, 1980, 20, 213-220.
- Sidhu, L. S., Kansal, D. K., & Kanada, B. S. Anthropometric and roentgenogrammetric assessment of physique and body composition of athletes specializing in throwing events. Journal of Sports Medicine and Physical Fitness, 1975, 15, 192-198.
- Silva, J. M., Shultz, B. B., Haslam, R. W., & Murray, D. A. Psychophysiological assessment of elite wrestlers. Research Quarterly, 1981, 52(3), 348-358.
- Siri, W. E. Body composition from fluid spaces and density. Berkeley, Calif.: Donner Lab. Med. Physics, University of California Rept., 19, 1956.

- Sloan, H. S. Estimation of body fat in young men. Journal of Applied Physiology, 1967, 23(3), 311-315.
- Smith, D. P. & Byrd, R. J. Body composition, pulmonary function and maximal oxygen consumption of college football players. Journal of Sports Medicine and Physical Fitness, 1976, 16, 301-308.
- Sodhi, H. S. A study of morphology and body composition of Indian basketball players. Journal of Sports Medicine and Physical Fitness, 1980, 20, 413-422.
- Sonstroem, R. J., & Bernardo, P. Intraindividual pregame state anxiety and basketball performance: A re-examination of the inverted-U curve. Journal of Sports Psychology, 1982, 4, 235-245.
- Spielberger, C. B., Gorsch, R. L., & Lushene, R. E. Manual for the state-trait anxiety inventory. Palo Alto, California: Counseling Psychologists Press, 1970.
- Spitler, D. L., Diaz, F. J., Horvath, S. M., & Wright, J. E. Body composition and maximal aerobic capacity of bodybuilders. Journal of Sports Medicine and Physical Fitness, 1980, 20, 181-188.
- Start, K. B., Gray, R. K., Glencross, D. J., & Walsh, A. A factorial investigation of power, speed, isometric strength, and anthropometric measures in the lower limb. Research Quarterly, 1966, 37(4), 553-559.
- Stone, M. H., Byrd, R., Tew, J. & Wood, M. Relationship between anaerobic power and Olympic weightlifting performance. Journal of Sports Medicine and Physical Fitness, 1980, 20, 99-102,

- Stromme, S. B., Ingjer, F., & Meen, H. D. Assessment of maximal aerobic power in specifically trained athletes. Journal of Applied Physiology, 1977, 42, 833-837.
- Sturlesi, F., & Antonelli, F. Psychological study of the environment of a first football team. International Journal of Sport Psychology, 1979, 10, 62.
- Swenson, E. J., & Conlee, R. K. Effects of exercise intensity on body composition in adult males. Journal of Sports Medicine and Physical Fitness, 1979, 19, 232-326.
- Tanner, J. M. The Physique of the Olympic Athlete. George Allen and Unwin: London, 1964.
- Taunton, J.E., Maron, H., & Wilkinson, J. G. Anaerobic performance in middle and long distance runners. Canadian Journal of Applied Sports Sciences, 1981, 6(3), 109-113.
- Taylor, H. L., Buskirk, E., & Henschel, A. Maximal oxygen uptake as an objective measurement of cardio-respiratory performance. Journal of Applied Physiology, 1955, 8, 73-80.
- Taylor, H. L., Wang, Y., Rowell, R., & Blomquist, G. The standardization and interpretation of submaximal and maximal tests of working capacity. Pediatrics, 1963, 32, 703-722.
- Taylor, J. The effects of mental fitness on athletic performance. International Journal of Sport Psychology, 1981, 12, 87-95.

- Thakur, G. P., Ojha, M. Personality differences of Indian table-tennis, badminton, and football players on primary source traits in the 16 PF. International Journal of Sport Psychology, 1981, 12, 196-203
- Thakur, G. P., & Thakur, M. Personality differences between the athletes and the non-athletes college males. International Journal of Sport Psychology, 1980, 2(3), 180-185.
- Thaxton, L. Physiological and psychological effects of short-term exercise addiction on habitual runners. Journal of Sport Psychology, 1982, 4, 73-80.
- Thomas, T. R., Zebas, C. J., Bahrke, M. S., Araujo, J. & Etheridge, G. L. Physiological and psychological correlates of success in track and field athletes. British Journal of Sports Medicine, 1983, 17(2), 102-109.
- Thompson, J. M. Prediction of anaerobic capacity: A performance test employing an optimal exercise stress. Canadian Journal of Applied Sports Sciences, 1981, 6(1), 16-20.
- Tschiene, P. Power Training principles for top-class throwers. Track Techniques, 1972, 1642-1654.
- Van Wieren, G. Cardiovascular endurance in soccer players. The Athletic Journal, 1978, 59, 74-75.
- Verma, S. K., Mahindroo, S. R., & Kansal, D. K. Factors limiting performance of football players on cycle ergometer. Journal of Sports Medicine, and Physical Fitness, 1978, 18, 43-47.

- Verma, S. K., Mahindroo, S. R., & Kansal, D. K. The maximal anaerobic power of different categories of players. Journal of Sports Medicine and Physical Fitness, 1979, 19, 55-62.
- Weinberg, R. S., & Ragan, J. Motor performance under three levels of trait anxiety and stress. Journal of Motor Behavior, 1978, 10(3), 169-176.
- Wicks, J. R., Sutton, J. R., Oldridge, N. B., & Jones, N. L. Comparison of the electrocardio- graphic changes induced by maximum exercise testing with treadmill and cycle ergometer. Circulation, 1978, 57(6), 1066-1070.
- Wilmore, J. H. Athletic training and physical fitness - physiological principles and practices of the conditioning process. Boston: Allyn and Bacon, 1977.
- Wilmore, J. H. Body composition in sport and exercise: directions for future research. Medicine & Science in Sports and Exercise, 1983, 15, 21-31.
- Wilmore, J. H. & Behnke, A. R. An anthropometric estimation of body density and lean body weight in young men. Journal of Applied Physiology, 1969, 27(1), 25-31.
- Wilmore, J. H., & Haskell, W. L. Body composition and endurance capacity of professional football players. Journal of Applied Physiology, 1972, 33(5), 564-567.

Wilmore, J. H., Royce, J., Girandola, R. N., Katch, F. I., & Katch, V. L.

Body composition changes with a 10-week program in jogging. Medicine and Science in Sports, 1970, 2(3), 113-117.

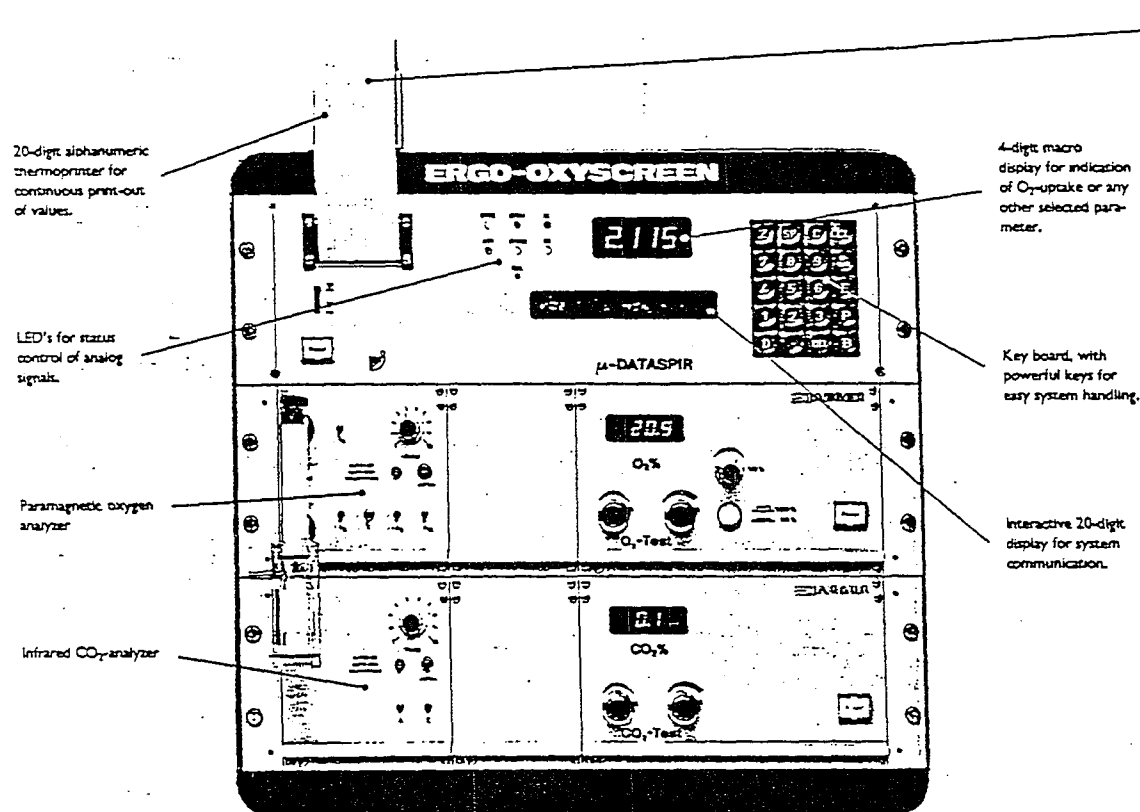
Wilmore, J. H., Royce, J., Girandola, N. R., Katch, F. I., & Katch, V. L.

Physiological alterations resulting from a 10-week program of jogging. Medicine and Science in Sports, 1970, 2(1), 7-14.

Withers, R. T., Roberts, R. G., & Davies, G. J. The maximum aerobic power, anaerobic power and body composition of South Australian male representatives in athletics, basketball, field hockey and soccer. Journal of Sports Medicine and Physical Fitness, 1977, 17(4), 391-400.

## APPENDIX A

Figure A1



- Processor-controlled volume calibration using a 1 l syringe for automatic volume correction.

- Permanent display of any selected parameter via key board.

- Direct and computer independent recording of spirometry and flow-volume loops on optional XY-recorder.

- Analog outputs for simultaneous recording of eight parameters on multi-channel recorder or plotter (option).

■ Text display for system communication and parameter characterizing.

- Alphanumeric printer, can be switched off.

Original protocol

PAGE NO.

Free programmable  
header. 5 lines,  
20 characters each

Input of:  
Examination date  
Identification number  
Patient data  
Ambient conditions

### On-line volume calibration

-----  
CALIBRATION  
CHECKED BY: J. B.

## APPENDIX

TIME	MIN	7.58
TV	L/MIN	14.49
	/MIN	11.00
WGS	"	38.87
WGGD	"	38.86
RG		8.82
RP	/MIN	188.8
WGL	L/MIN	1.54
WGGD	L/MIN	1.17
WGS/RP	ML	15.1
WGGD/RP	ML	24.1
NET		8.8
WGGD		15.1

Measurements print-out  
continuously each 30 sec

Time  
MV  
Bf  
FO<sub>2</sub>  
FCO<sub>2</sub>  
RQ  
HR  
VO<sub>2</sub>  
VCO<sub>2</sub>  
VO<sub>2</sub>/HR  
VO<sub>2</sub>/kg  
MET  
EQO<sub>2</sub>

```
MEAN VALUES
TIME TOT./MIN 5.58
MW L/MIN 28.7
SF /MIN 24.88
V02 : 8.15
V002 : 8.18
RQ : 8.77
HR /MIN 164.8
V02 L/MIN 1.39
V002 L/MIN 1.24
V02/KG ML 15.3
V002/KG ML 14.1
MET 5.8
EPO2 13.8
```

Mean values at any  
desired time

Time - Phase time min  
MV. - Minute ventilation (STPS)  $\text{lmin}^{-1}$   
Bf - Breathing frequency  $\text{lmin}^{-1}$

$FO_2$	- $O_2$ -expiratory difference	Vol %
$FCO_2$	- $CO_2$ -expiratory concentration	Vol %
RQ	- Respiratory quotient	

HR = Heart rate      1/min  
 $\dot{V}O_2$  = Oxygen uptake      (STPD) 1/min (mol/s)  
 $\dot{V}CO_2$  =  $CO_2$  output      (STPD) 1/min (mol/s)

$\dot{V}O_2/\text{HR}$ - Oxygen pulse	ml (mmol)
$\dot{V}O_2/\text{kg}$ - Relative $\dot{V}O_2$ uptake	ml / (min · kg), mmol / (s · kg)
MET - Metabolic units	multiples of basic metabolic rate

$\text{EQO}_3$  - Equivalent  $\text{O}_3$



Figure A2

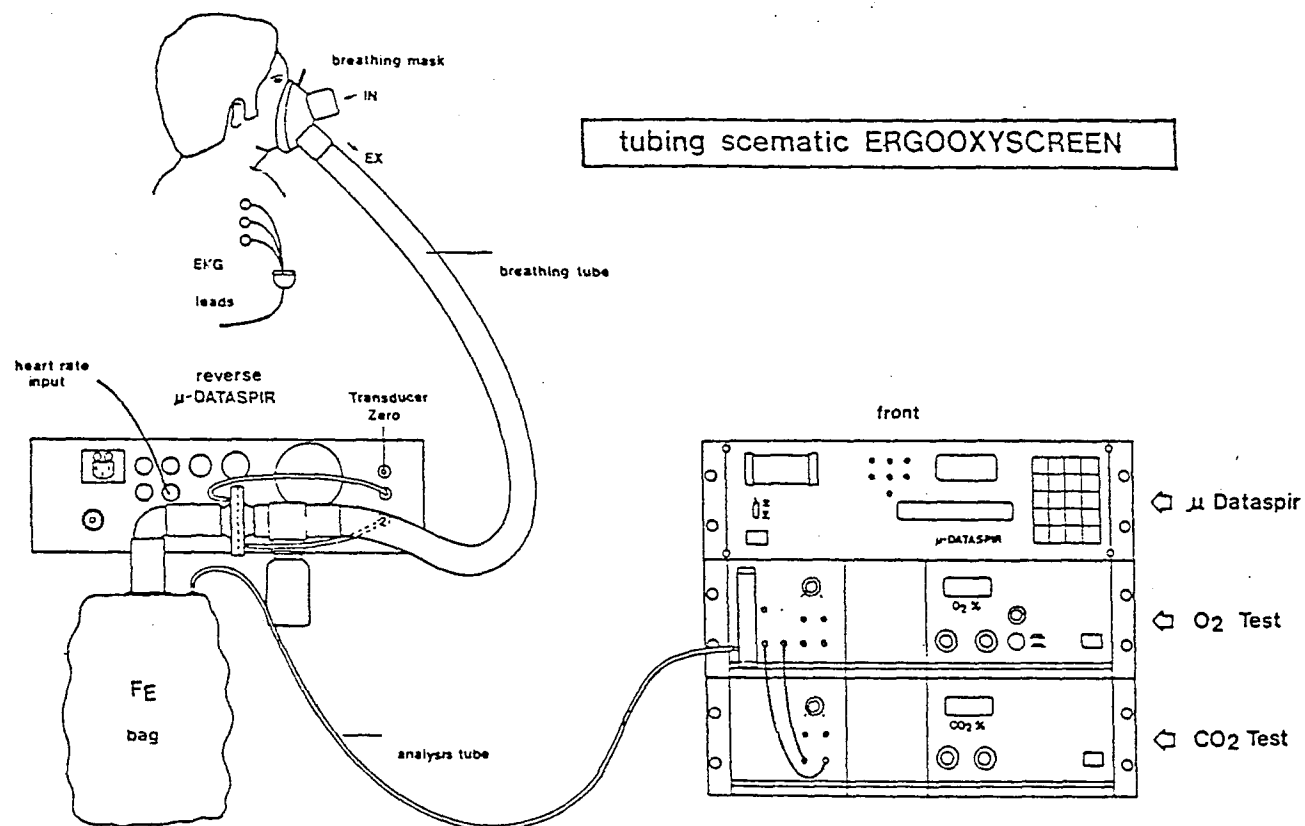
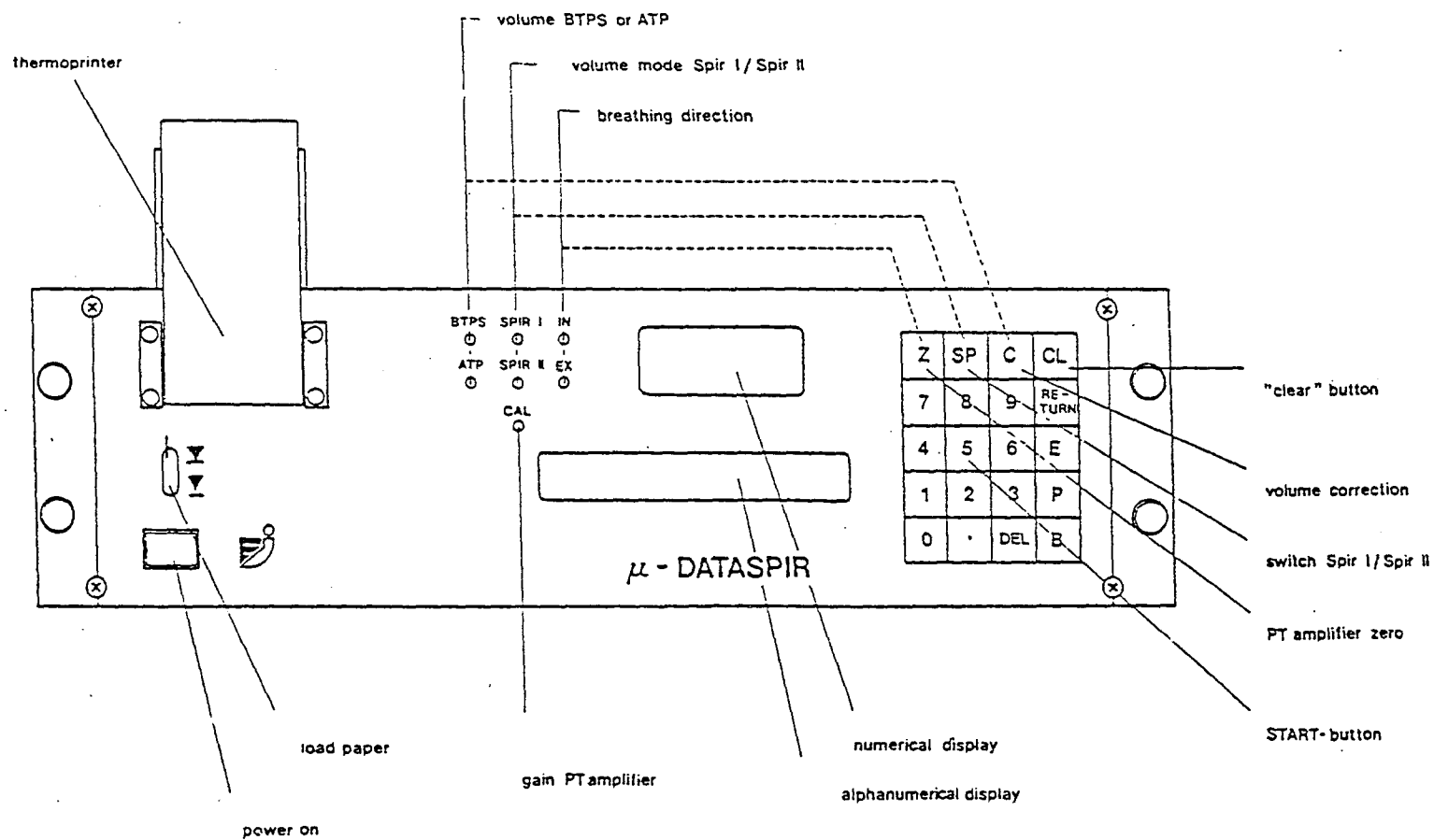


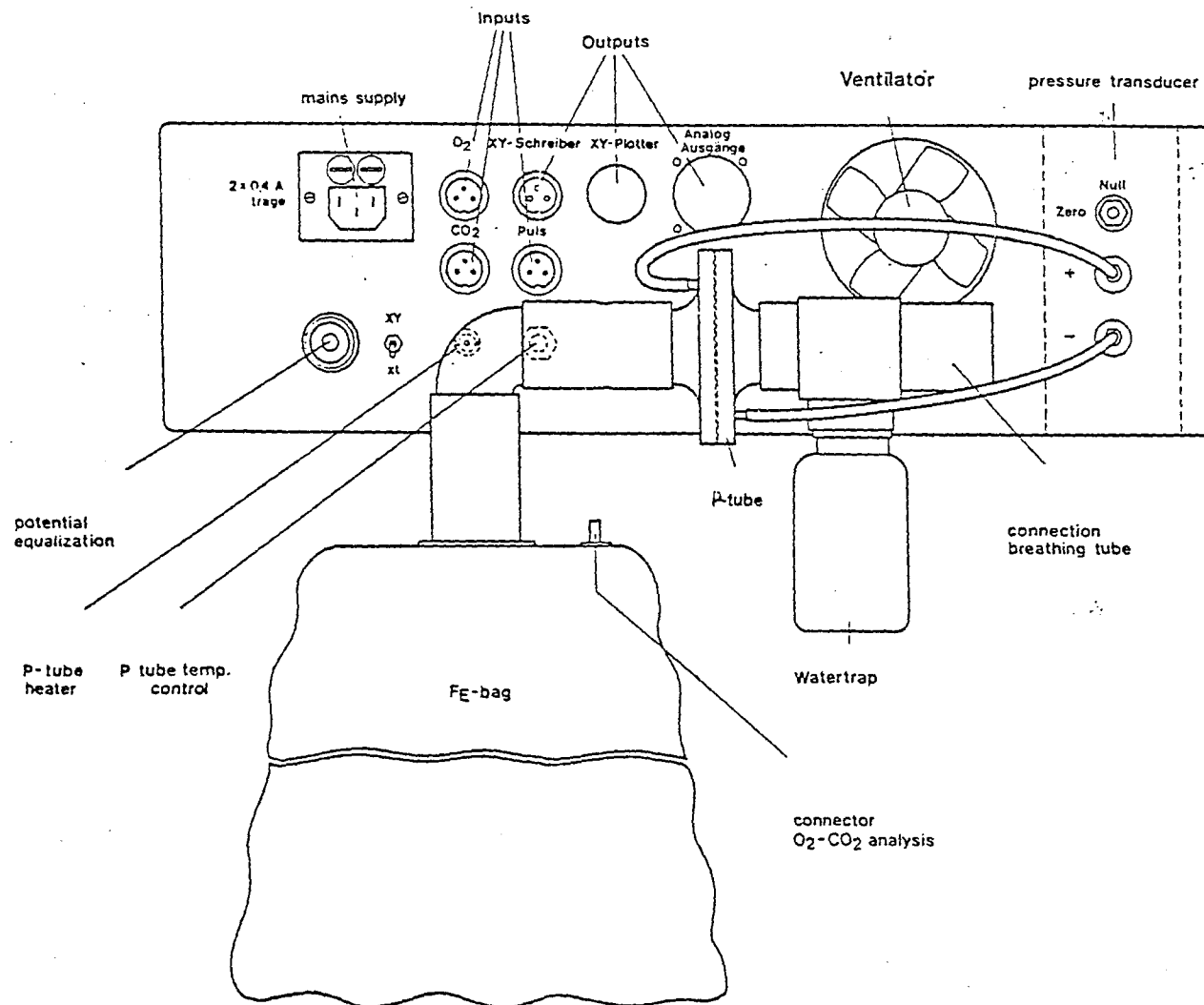
Figure A3



Front-panel u-Dataspir

Figure A4

reverse  $\mu$ -DATASPIR



## APPENDIX B



## VITA

Name: Jasem M. Ramadan  
Birthdate: September 13, 1950  
Place of Birth: Kuwait, State of Kuwait

## Education:

- Ph.D. - Louisiana State University,  
Baton Rouge, Louisiana, August 1984
- M.S. - Indiana University  
Bloomington, Indiana, December 1979
- B.S. - Higher Institute of Sports Education  
Cairo, Egypt, June 1973

## Professional Experience:

- Sports Supervisor, Kuwait University, Kuwait  
October 1973 - February 1978
- Referee in the Kuwait National Volleyball League  
1973 - 1978
- Basic and Advanced Coaching Certificate of the  
International Volleyball Federation Coaching Committee  
1974 and 1975
- Assistant Coach of the Kuwait National Volleyball Team  
1974 - 1976
- Kuwait University Varsity Teams' Coach (Male and Female)  
September 1974 - February 1978
- Kuwait Volleyball Coach to the World University Games  
Sofia - Bulgaria, 1975
- Coach of Kuwait National Junior Volleyball Team  
1975 - 1976

International Volleyball Referee Certification  
1977

Manager - Kuwait National Volleyball Team that Won the  
Championship of the First Pan-Arab Volleyball Tournament  
December 1977

Member of the Board - Kuwait Volleyball Association  
1977 - 1978

President of the Technical Committee -  
Kuwait Volleyball Association  
1977 - 1978

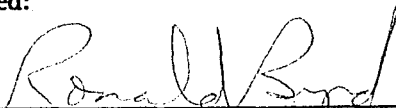
## EXAMINATION AND THESIS REPORT

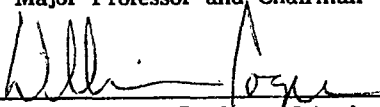
**Candidate:** Jasem M. Ramadan

**Major Field:** HPERD (Exercise Physiology)

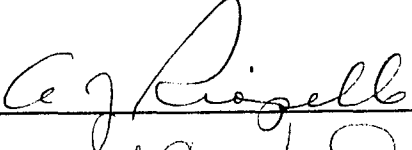
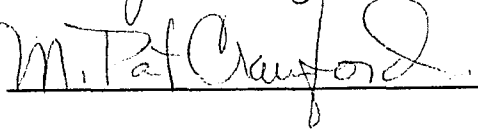
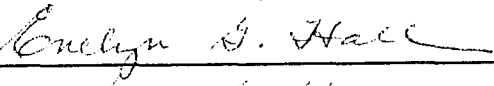

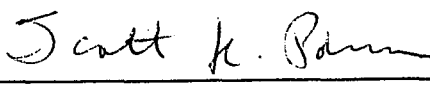
**Title of Thesis:** Selected Physiological, Psychological, and Anthropometric  
Characteristics of the Kuwaiti World Cup Soccer Team

**Approved:**

  
Major Professor and Chairman

  
Dean of the Graduate School

### EXAMINING COMMITTEE:

**Date of Examination:**

July 16, 1984